Interpersonal sensitivity and paranoid ideation in a sample of healthy individuals with low, moderate, and high schizotypy

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Systematic Review

&

Empirical Research Project

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The use of digital technology in the research and assessment of schizotypy: a systematic review

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ABBREVIATIONS

Abbreviations	Definitions
CAVE	Cave automatic virtual environment
DT	Digital technology
EAR	Electronically Activated Recorders
eHEALTH	Electronic Health
EMA	Ecological Momentary Assessment
EPHPP	Effective Public Health Practice Project
ESQUIZO-Q-A	Oviedo Schizotypy Assessment Questionnaire-Abbreviated
GAD	Generalised Anxiety Disorder
HMD	Head Mounted Display
mHEALTH	Mobile Health
O-LIFE-R	Oxford-Liverpool Inventory of Feelings and Experiences-Reduced Version
PTSD	Post-traumatic Stress Disorder
SMI	Serious mental illness
SPQ	Schizotypal Personality Questionnaire
VR	Virtual Reality
VRET	Virtual Reality Exposure Therapy

Abstract

Background: Schizotypy has been described as a vulnerability factor to the development of schizophrenia-spectrum disorders with its three dimensions: positive, negative and disorganised, being associated to different patterns of symptoms and impairments. Digital technologies (DTs) have proved to be viable and accepted tools for assessing, treating and preventing a wide range of mental health disorders across both clinical and non-clinical populations. This review is focused on the use of DT in the assessment and research of any characteristics in high schizotypy in non-clinical individuals.

Method: A systematic review was carried out across four online databases: PsyINFO, Embase, Ovid and Web of science. The search yielded 5,784 articles, after screening, seven studies met eligibility criteria, with the quality assessment conducted for each of them.

Results: The seven studies included examined a total of 407 participants (156 males, 251 females). The number of participants in each study ranged from 24 to 117. The review illustrated the feasibility and safety of a wide range of DTs in assessing and researching a breadth of characteristics in healthy adult individuals including screening for schizotypy personality traits. The EPHPP tool was used to assess the studies' qualities. All studies received a global rate of 'weak'.

Conclusions: Limited preliminary data suggest that DTs are viable assessment and research tools in schizotypy healthy populations. The review highlights the presence of insufficient information about the use of DTs to directly assess schizotypy. Suggestions for future research and areas that needs further exploration are discussed.

Keywords: Digital technology · Virtual Reality · Schizotypy · Psychosis proneness · Psychosis prone personality

1. Introduction

The digital revolution of the past two decades has led to significant changes in both individuals' lives and in the health care sectors (Hollis et al. 2015). With 89% of adults in the UK aged 16 to 34 years, accessing the internet on a daily basis (Office for National Statistics, 2018) and with those aged between 16-54 having the highest percentage of smartphone ownership (>90%) (O'Dea, 2019), people are accustomed to and comfortable with using digital technologies (DTs). In this review, we use the term of DT used by Fairburn et al. (2016), which includes: computers, the internet, mobile devices such as smartphones, and mobile software applications (apps).

Since the early nineties, the employment of e-Health tools within health care sectors has consistently gained popularity. Initially driven by an exploratory intent to investigate whether the effectiveness of computer-based interventions equalled traditional face-to-face therapies (Carlbring et al. 2017; Andersson et al. 2014), it now aims to identify new effective ways of working to bridge the gap between the limited resources available and the high demand for health treatments (NHS 2016 and 2017).

The benefits brought by the employment of DTs, both immersive and non-immersive, has already been witnessed across a wide range of mental health conditions, such as depression (Wagner et al. 2014), anxiety (Griffiths et al. 2010; Arnberg et al. 2014), panic (Carlbring et al. 2006), psychotic (Naslund et al. 2015a) and post-traumatic stress disorders (Kuester et al. 2016).

The application of DTs across all stages of mental health treatments: prevention, assessment and intervention (Naslun et al. 2015c), has shown that they are well-accepted tools in supporting individuals to better manage their mental health and wellbeing.

1.1. The use of digital technology within psychological interventions for serious mental illnesses

Several systematic reviews have already demonstrated mHelath and eHealth interventions to be highly feasible and acceptable (Berry et al. et al. 2016) for short-term use amongst clinical populations with severe mental health illnesses (SMIs), such

as schizophrenia, schizoaffective disorder, psychosis, or bipolar disorder and to be effective tools in enhancing people's care across different areas of life e.g. symptoms management, goal setting, sleep hygiene, relapse prevention and recovery enhancement as well as, providing better accessibility to psychoeducation and self-help courses (Naslund et al. 2015a and 2015c; Firth et al. 2015).

In addition to this, observation analyses have described mobile and internet-based interventions to be effective tools in reducing positive symptoms and improving people's quality of life (Ben-Zeev et al. 2014; Batra et al. 2017; Torous et al. 2018) by supporting the development of new patterns of physical activity (Kane et al. 2012; Macias et al. 2015; Naslund et al. 2015b) and enhancing treatment adherence (Montes et al. 2012).

Other innovative types of intervention that have illustrated a similar advancing role in mental health interventions are those that include immersive virtual reality. Virtual reality has been shown to be a safe and feasible tool in populations at risk of onset psychosis, also defined as "at-risk mental state" and to be a well-tolerated tool to investigate psychotic symptoms (Rus-Calafell et al. 2018). Several pieces of research have confirmed its safety in assessing and treating a wider range of enduring mental health difficulties, such as psychosis, substance misuses, depression and eating disorders (Valmaggia et al. 2016b; Freeman et al. 2017).

For clarity, in this study we use the descriptions elaborated by Freeman et al. (2017, page 2393) to differentiate immersive DTs from those that are not: "immersive digital technologies substitute real-world sensory perceptions with digitally made ones by creating a life-sized interactive computer-generated environment" in which individuals are able to experience a sense of presence (Slater 2014).

There is growing body of literature demonstrating the pivotal role of incorporating virtual therapies, such as virtual reality exposure therapy (VRET), as part of traditional mental health psychological interventions. From the early nineties to now, the use of in virtuo exposure has proven to be either equally or superiorly effective as conventionally delivered treatments for a wide range of anxiety disorders symptoms (Carl et al. 2019), such as acrophobia (Rothbaum et al. 1995) arachnophobia (Garcia-Palacios et al. 2002),

fear of flying (Mühlberger et al. 2003), post-traumatic stress disorder (PTSD), social anxiety disorder and generalised anxiety disorder (GAD) (Reger et al. 2016; Bouchard et al. 2017; Repetto et al. 2011).

Immersive virtual environments generated through CAVE and HMD systems have allowed researchers to explore the psychological processes and mechanisms underlying paranoid thoughts, as well as to investigate the determinants of the persecutory appraisals experienced by the individuals with psychiatric diagnoses in neutral controlled social environments (Valmaggia et al. 2007, 2016a). The results obtained from these studies matched the findings of the study (Freeman et al. 2003) that applied the same paradigm in healthy populations, suggesting the presence of a continuum of psychotic symptoms across normative and clinical populations. This is in agreement with theories describing a continuity between clinical and non-clinical psychosis populations (van Os et al. 2009), which Claridge et al. (1995) defines as a fully dimensional approach where schizotypy, described as a combination of personality, environmental and genetic variations, is thought to be normally distributed throughout clinical and subclinical populations. Furthermore, Claridge's fully dimensional model argues that schizotypic psychopathology traits are also on a continuum as they are part of normal individual differences expressed in healthy manifestations (e.g., creativity) across the general population (Kwapil et al. 2015).

1.2. Schizotypy and its multidimensionality

The term schizotypy was originally introduced to describe the vulnerability to schizophrenia spectrum disorders. Defined as an enduring personality structure that enhances an individual's predisposition to develop schizophrenia due to a genetically influenced neuro-integrative defect (schizotaxia), the term has been more recently conceptualised as a multidimensional continuum of personality characteristics and experiences, ranging from minimal impairment, to subclinical deviance, to personality pathology, to full-blown psychosis (Kwapil et al. 2008; van Os et. 2009; Neuvo et al. 2012).

This new multidimensional definition introduced an alternative view of the relationship between schizotypal personality and schizophrenia, and provided an explanation for the

high prevalence of unusual experiences recorded among samples of people who are psychologically healthy (Linscott and van Os 2010), where schizotypy functions as a part of personality free of schizophrenia-liability (Claridge 1997).

The multifactorial composition of schizotypy has been supported by several studies (Stefanis et al. 2002, Kwapil et al. 2008) with the general consensus supporting the idea of being composed of three factors, which broadly reflect symptom dimensions of schizophrenia (Raine 1991):

- a positive dimension – characterised by hallucinations, ideas or reference, magical thinking or paranoid ideation;
- a negative dimension – which refers to blunted affect, social anxiety and isolation;
- and a disorganised dimension – which comprises odd behaviours and speech.

Literature reports that the positive and negative schizotypy dimensions are differently related to psychopathology, social functioning and personality, with positive schizotypy being distinctively linked to psychotic-like experiences, and negative schizotypy being associated more with schizophrenia-spectrum disorders (Fonseca-Pedrero et al. 2011; Kwapil et al. 2013; Debbané et al. 2014).

1.3. Schizotypy and paranoid ideation

Over the past years there has been a growing consensus about the existence of a continuum between psychotic delusions and common paranoid ideations. Studies have demonstrated the presence of psychotic-like symptoms in healthy populations who did not have a diagnosable disorder (Neuvo et al. 2012), confirming that paranoid thinking is not confined to people with severe mental illness.

Immersive DTs, such as VR, have proved to elicit and assess paranoid ideations in non-clinical as well as clinical groups. In a pilot study investigating persecutory ideations using a virtual social environment, Freeman et al. (2003) identified that healthy individuals attributed mental states to neutrally behaving virtual reality characters

(avatars), and that both anxiety and interpersonal sensitivity played a key role in participants' vulnerability to persecutory thoughts.

Similar findings were discovered in subsequent analyses (Freeman et al. 2005), which also showed that persecutory ideations, experienced by healthy participants during the virtual reality, were associated with having equivalent thoughts in real life.

More recently, a study investigating the link between paranoia ideations and social performance in healthy participants, illustrated that, as in clinical populations, those who reported a higher state of paranoia experienced greater negative components of social performances in a virtual social environment (Riches et al. 2019).

1.4. Current review

The effectiveness and viability of both immersive and non-immersive DTs in assessing, treating, and researching symptoms related to several mental health problems has been widely demonstrated (Naslund et al. 2015a, Freeman et al. 2017). The present review aimed to evaluate the application of DTs for assessing schizotypal traits in healthy populations. However, after conducting an initial in-depth literature search and evaluation it became clear that no studies employed DTs to directly assess schizotypal traits in non-psychiatric individuals and that schizotypy traits were usually measured through the administration of self-report measures (i.e. questionnaires) assessing schizotypy or their computerised versions.

For these reasons, the original aim of the review was changed to reviewing studies that used DTs to present a novel task that could not be presented other than via DTs to healthy adults who were also assessed on schizotypy as a part of their study participation. A secondary aim was to review and critically evaluate the quality of the selected studies.

2. Methods

A systematic synthesis review was conducted of studies that use a DT to measure and investigate characteristics in non-clinical populations whose schizotypal personality

traits have been measured. This review is registered in the PROSPERO register: CRD42019129210

2.1. Selection procedure

2.1.1. Literature search

The following four databases were used to identified relevant studies: PsyINFO, Embase, Ovid, and Web of Science. The search was limited to studies published up until March 2019.

2.1.2. Inclusion and exclusion criteria

The primary inclusion criteria of this review were original peer-reviewed publications that: (1) were written in English; (2) assessed schizotypal personality or one of its domains with any self-report measure of schizotypy listed in "Mason O. J. (2015). The Assessment of schizotypy and its clinical Relevance" review; (3) used DT to present a novel task that could not be presented other than via DTs; (4) studied non-clinical samples of young adults (>16 years) or adults; (5) used both RCT and non-RCT designs.

The publications were not included if they were: (1) literature reviews; (2) conference abstracts; (3) chapters and books; (4) thesis and other grey literature; (5) not written in English; (6) using samples of children under the age of 16 years; (7) using clinical samples; (8) using a computerised version (rather than using digital technology to administer a novel task which could not be presented using e.g. pen-and-paper) of a well-established task, such as Wisconsin Card Sorting Test, Span of apprehension, Continuous Performance Test, Simon or Stroop task, eye-movement task; (9) using digital technology for brain imaging; (10) published before 1983.

2.1.3. Search criteria

The following terms were used to identify relevant studies: 'virtual real*' OR 'teleme*' OR 'telemedicine' OR 'telepsych*' OR 'telehealth*' OR 'eHealth' OR 'mHealth' OR 'mobile phone*' OR 'mobile health' OR 'mobile tech*' OR 'mobile app*' OR 'smartphone*' OR 'internet' OR 'online' OR 'online system*' OR 'social media' OR

‘Web-based intervention*’ OR ‘augmented real*’ OR ‘e-learning’ OR ‘computer*’ OR ‘computer assisted therapy’ OR ‘app*’ AND ‘schizoty*’ OR ‘psycho*-proneness’ OR ‘psycho*-prone’ OR ‘psycho* prone personality’ OR ‘psychotic-like’ OR ‘psychosis-like’. Appropriate truncations were implemented to identify and ensure that any variation of the search terms was included in the search.

2.1.4. Quality assessment tool

The Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies (EPHPP, National Collaborating Centre for Methods and Tolls, 2008) was used to assess a risk of bias and quality appraisal. This tool evaluates the methodological accuracy of quantitative studies across six key domains: selection bias, study design, confounding variables, blinding, data collection methods, and withdrawals and dropouts. Each publication’s content was rated as ‘strong’, ‘moderate’ or ‘weak’ in each domain. A global rating was then determined for each publication as follows:

- global ‘strong’ – at least four key domains rated as ‘strong’ with none rated as ‘weak’.
- global ‘moderate’ – one domain rated as ‘weak’ with the rest being rated as either ‘strong’ or ‘moderate’.
- global ‘weak’ – two or more domains rated as weak.

To ensure the correctness of the ratings, two raters independently reviewed the quality of each study, compared their ratings and discussed any discrepancies until an agreement was reached. The EPHPP tool has been shown to have good content and construct validity and adequate test-retest reliability (Thomas et al. 2004; Jackson and Waters, 2005; Armijo-Olivo et al. 2012).

3. Results

3.1.Information extraction

A total of 5,784 articles were retrieved from PsyINFO, Embase, Ovid, and Web of Science, of which 2,576 were duplicates. 3,208 were screened by title and abstract. 10% were reviewed by the second rater to identify whether they met full inclusion criteria with any uncertainties discussed. 141 potential articles were identified for full text

screening. 10% of these were reviewed by the second rater to guarantee screening accuracy. 134 out of 141 studies were excluded. PRISMA guidelines were reviewed and followed (see Fig. 1).

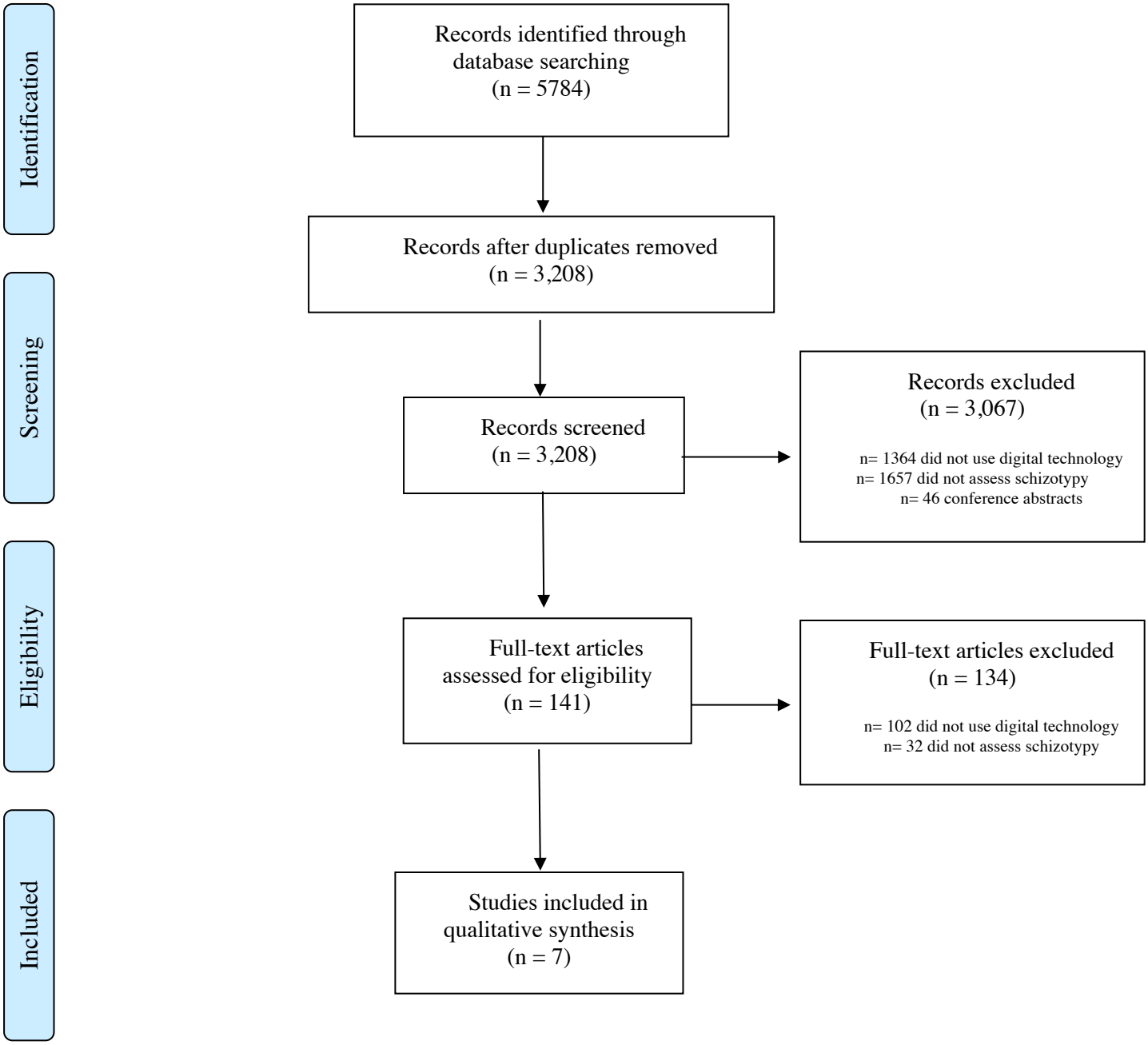

Fig 1. PRISMA flow diagram

3.2.Quality assessment ratings

Two raters carried out independent ratings, resolving disagreements by consensus. As shown in Table 1 the majority of studies received an EPHPP global rating of ‘weak’. The breakdown of the ratings for each EPHPP domains are shown in Table 2 and Table 5. Despite all studies achieving an overall rating of ‘weak’, it is important to highlight that all papers received a ‘strong’ rating for their data collection methodology and, where applicable, for their descriptions of the numbers and reasons of withdrawals and drop-outs. The overall ‘weak’ scores on the other components: sample selections bias, study design, confounders and blinding, were issues that are discussed below (paragraph 3.3.4. page 24).

Table 1. Studies using digital technology to assess different characteristics in non-clinical schizotypy populations

Authors	Area Explored	Design	Subjects	DT equipment	Experimental task	Schizotypy measure	Main findings
Steinisch et al. (2011) – Italy	The relationship between visual perspective taking (egocentric and allocentric mental transformations) and personality trait of schizotypy	Cross-sectional study	24 non-clinical volunteers, 12 females (average age 27.3 ± 5.4 years) and 12 males (average age 28.4 ± 4.0 years)	An off-the-shelf 19" monitor placed at a distance of 40 cm in front of the subjects and used for visualization, a computer keyboard	Imagined Rotation Phase followed by Appearance Task and Item-position task	Italian translation of Schizotypal Personality Questionnaire (SPQ) Raine, 1991 (Fossati et al. 2003)	Individuals with high-schizotypy were significantly faster than those with low-schizotypy during the Imagined Rotation Phase (array and self-chair rotations) and during the Task Phase (self-chair). Participants with high-schizotypy were also faster in the self-chair than in the self-avatar rotation, supporting the existence of a dissociation between perspective changing and perspective taking in high-schizotypy
Da Silva et al. (2018) - Canada	The multi-faceted of the motivation and reward system in a non-clinical sample	Cross-sectional study	117 non-clinical volunteer undergraduate students, of whom 96 were included in the final analyses, 58 females and 38 males Mean age: 19.8 years (S.D. 2.4) Age range: 17-32 years	All computer tasks were presented on a 30″ LCD display, with the participant providing input for each task either with the keyboard (for the IAPS, EEfRT, etc.) or with a standard video game controller (MCT)	The International Affective Picture System (IAPS). The Cued Reinforcement Reaction Time (CRRT) task The Kirby Delay Discounting (Kirby DD) task The Effort Expenditure for Rewards Task (EEfRT) The Multitasking in the City Test (MCT)	The Likert-scale version of the Schizotypal Personality Questionnaire (SPQ) - Raine, 1991	2 groups of individuals with different motivation performance profile were identified: group 1 was characterised by impaired reward expectancy, whereas group 2 by impaired reward valuation, effort valuation and action selection/decision making. The groups did not show any significant difference on performance in reward responsiveness. They did not differ by age, sex, level of education, cognitive functioning, depressive symptoms and overall schizotypal traits. Both groups did not show any difference regarding the score reported by the TEPS-Con, (Temporal Experience of Pleasure Scale to evaluate consummatory pleasure) and TEPS-Ant (Temporal Experience of Pleasure Scale to evaluate anticipatory pleasure)

Van Doorn et al. (2018) - Australia	The influence of schizotypal personality traits on susceptibility to body ownership illusions	Cross-sectional study	44 non-clinical members of the Australian general public 27 females and 17 males Mean age: 29.36 years (S.D. 8.14) Age range: 18-58 years	A pair of Head-Mounted Display (HMD) goggles (Sony HMZ-12H Head Mounted Unit 5.6V). The HMD goggles were connected to a video camera (Sony Handy-Cam HDR-XR260) via a High Definition Multimedia Interface (HDMI) box (Sony HMZ-T2P). The camera was mounted onto a tripod facing an artificial doll. The artificial doll (69 cm long × 25 cm wide) was placed on a small table, with its lower extremities (waist and legs) visible to the participants through the HMD goggles	Body Swapping Illusion tasks	The Likert-scale version of the Schizotypal Personality Questionnaire (SPQ) - Raine, 1991	Individuals with high cognitive perceptual schizotypy traits were more liable to experience a sense of immersion, especially in the synchronous condition
Vastano et al. (2014) - Italy	The relationship between perspective taking (embodied and disembodied allocentric simulation) and personality trait of schizotypy	Cross-sectional study	83 non-clinical volunteers, of whom 69 were included in the final analyses, 32 females (average age 24.3 ± 4.7 years) and 37 males (average age 22.9 ± 7.1 years)	A 19" monitor placed at a distance of 40 cm in front of the subjects	The Imagined Rotation Phase and the Task Phase	Italian translation of Schizotypal Personality Questionnaire (SPQ) Raine, 1991 (Fossati et al. 2003)	In general, High-schizotypy individuals were significantly slower than those with low-schizotypy. High-schizotypy individuals employed significantly more time than Low-Schizotypy individuals only when they performed an Appearance task after the mental self-rotation cued by an object (e.g., chair) but not when cued by an avatar

García-Montes et al. (2014) - Spain	The relationship between high schizotypy and low schizotypy and spatial abilities	Cross-sectional study	30 females from the University of Almería participated in the experiment. 15 of them were high schizotypal subjects (mean age = 18.3, SD = 0.4) and 15 were low schizotypal subjects (mean age = 18.2, SD = 0.6)	"The Boxes Room" task was administered on an HP 2.1GHz notebook equipped with 4 GB of RAM and a 15.6 XGA TFT colour screen (1,024 × 768). Participants navigated through the maze by manipulating a Logitech joystick and received auditory feedback from the computer speaker	Spatial memory task and spatial memory recognition task	Oviedo Questionnaire for Schizotypy Assessment (ESQUIZO-Q-A) (Fonseca-Pedrero et al. 2012)	High and Low schizotypal female subjects did not differ in their spatial abilities. Their performance was very similar in the virtual spatial memory task that demanded memorisation and retrieval of the location of 5 rewarded boxes in 16 possible positions. In the spatial memory recognition task, groups were equally accurate in the recognition of the rewarded boxes from different views of the virtual experimental room. Overall, no significant differences between groups were reported
Rus-Calafell et al. (2013) - Spain	The capacity of schizotypy and alexithymia traits, in combination with affectivity to predict facial emotion recognition capability	Cross-sectional study	98 healthy volunteers were recruited from different faculties of the University of Barcelona and the Adult Education Centre Rius i Taulet (Barcelona) 66 females and 32 males Mean age: 32.58 years (S.D. 9.23) Age range: 18-65 years	A laptop with a 15.6-inch monitor and stereoscopic view was used for the task presentation (Acer Aspire 5738dg, 2.2GHz Core 2 Duo, 4GB of RAM, and ATI Radeon HD 4570 graphics). Participants were required to use 3D glasses. For the virtual facial stimuli tasks, the faces were first morphed according to the action units (AUs) in the FACS, using 3Ds Max® (Autodesk, Inc., USA). Further modelling and animations were also applied using 3D Max. To make the images more realistic, textures were included with the help of Photoshop 6.0®. Finally, 3DVIA Virtools® was used to correctly display each emotion during the final presentation	Facial emotion recognition task using natural static images (photographs) and dynamic images (virtual reality faces)	The Oxford-Liverpool Inventory of Feelings and Experiences-Reduced Version (O-LIFE-R; Spanish adaptation by Gutiérrez-Maldonado et al. 1999)	Positive significant correlations were found between alexithymia and committed errors in both presentation conditions (photographs and virtual reality). There was a positive correlation between alexithymia and schizotypy traits, as well as alexithymia and negative affect. Alexithymia was also negatively associated with positive affect. Schizotypy was positively correlated to negative affect

Minor et al. (2018) - USA	The relationship between personality trait of schizotypy and affect and social engagement	Time-series study	904 subjects completed psychometric questionnaire, of whom 46 undergraduates participated in the study 25 high schizotypy individuals (mean age: 19.92 years, S.D. 2.14, age range: 18-27 years, 64% females) 21 low schizotypy individuals (mean age: 19.81 years, S.D. 1.86, age range: 18-25 years, 47.62% females)	Electronically activated recorder (EAR) which is an application-based computer program that is combined with widely used technology and smartphone devices to capture a person's natural environment via audio recordings	Participants were instructed to wear an iPod Touch running the EAR for 2 consecutive days during their waking hours.	The Likert-scale version of the Schizotypal Personality Questionnaire (SPQ) - Raine, 1991	High schizotypy individuals showed greater negative affect when compared to low schizotypy. When assessing specific traits, EAR and ecological momentary assessment (EMA) converged to show that positive schizotypy predicted negative affect. High schizotypy status moderated links between negative affect and social engagement.

SPQ, Schizotypal Personality Questionnaire; LCD, liquid-crystal display; IAPS, International Affective Picture System; EEfRT, Effort Expenditure for Rewards Task; MCT, Multitasking in the City Test; CRRT, Cued Reinforcement Reaction Time; Kirby DD, Kirby Delay Discounting; PAI, Personality Assessment Inventory; AES-S, Apathy Evaluation Scale; TEPS-Con, Temporal Experience of Pleasure Scale to evaluate consummatory pleasure; TEPS-Ant, Temporal Experience of Pleasure Scale to evaluate anticipatory pleasure; CES-DB, Centre for Epidemiologic Studies–Depression Scale; HMD, Head-Mounted Display; HDMI, High Definition Multimedia Interface; ESQUIZO-Q-A, Oviedo Schizotypy Assessment Questionnaire-Abbreviated; AUS, action units; FACS, Facial Action Coding System; PERT96, Penn Emotion Recognition Test-96 Faces version; O-LIFE-R, Oxford Liverpool Inventory of Feelings and Experiences-Reduced Version; TAS-20, Toronto Alexithymia Scale-20; PANAS, Positive and Negative affect schedule; EAR, Electronically activated recorder; EMA, ecological momentary assessment.

3.3. Overview of studies

3.3.1. Studies' aims

The aims of the studies varied from exploring between-groups differences in regard to egocentric and allocentric mental transformations (Vastano et al. 2014; Steinisch et al. 2011), spatial memory abilities (García-Montes et al. 2014) and affective disturbance and social engagement (Minor et al. 2018), to investigating the presence of a correlation between schizotypal traits and other constructs, such as alexithymia, negative affect (Rus-Calafell et al. 2013), levels of immersion in virtual reality illusion task (Van Doorn et al. 2018) and reward responsiveness (Da Silva et al. 2018). None of the studies aimed to assess schizotypy as a primary construct of interest.

3.3.2. Samples' demographics

The studies were carried out across five different countries Italy (n= 2) (Steinisch et al. 2011, Vastano et al. 2014), Spain (n=2) (García-Montes et al. 2014, Rus-Calafell et al. 2013), Canada (n=1) (Da Silva et al. 2018), Australia (n=1) (Van Doorn et al. 2018) and USA (n=1) (Minor et al. 2018). In the two pieces of research conducted in Italy (Steinisch et al. 2011, Vastano et al. 2014) there was an overlap of 4 authors. A total number of 407 participants took part in the studies, of which 251 were females and 156 males. Only one study had a single gender population (García-Montes et al. 2014). Four studies reported the age range of their samples (Da Silva et al. 2018, Van Doorn et al. 2018, Rus-Calafell et al. 2013, Minor et al. 2018), whereas the remaining three only stated the mean age and standard deviation (S.D.) (Steinisch et al. 2011, Vastano et al. 2014, García-Montes et al. 2014) – the widest age range was 18-65 and the youngest age recorded was 17. The highest mean age was 32.58 years with a S.D. of 9.23 and the lowest was 18.2 with a S.D. of 0.6. All participants were recruited from non-clinical populations as per inclusion criteria: 287 individuals were healthy volunteers (of which 96 were undergraduate students and 98 were from a university), 44 were non-clinical members of the general public, 46 were ungraduated students and 30 were recruited from a university.

3.3.3. Studies' designs

No study mentioned or described the research design used. From reviewing the papers, it was concluded that six out of seven studies were cross-sectional observational analyses (Da Silva et al. 2018, Van Doorn et al. 2018, Rus-Calafell et al. 2013, Steinisch et al. 2011, Vastano et al. 2014, García-Montes et al. 2014) and they all used one-time measurement of exposure and outcome. The remaining one was a time series study (Minor et al. 2018) which collected data at pre-programmed intervals across two days.

In six studies participants undertook more than one task or were placed in more than one condition (Steinisch et al. 2011, García-Montes et al. 2014, Vastano et al. 2014, Da Silva et al. 2018, Van Doorn et al. 2018, Minor et al. 2018) whereas in only one study they were administered one experiment (Rus-Calafell et al. 2013). Of note, only Rus-Calafell et al. (2013) clearly reported that the entire procedure of their investigation was carried out in a single session.

With the exception of Minor et al. (2018) and Rus-Calafell et al. (2013), participants across all studies consecutively completed tasks at one-time point, but this was not explicitly described by the authors. All the studies were carried out in high-income countries.

In exchange for participation, one study offered experiential credit or cash (Minor et al. 2018), four studies did not offer any remuneration as they recruited volunteers (Steinisch et al. 2011, Vastano et al. 2014, Da Silva et al. 2018, Rus-Calafell et al. 2013), and two did not mention any type of compensation (García-Montes et al. 2014, Van Doorn et al. 2018).

3.3.4. Studies' quality assessment ratings breakdown

A breakdown of EPHPP ratings for each study is illustrated in table 2. All studies were given a global rating of weak mainly due to their publication biases, which are discussed in more detail on page 36. There are weaknesses in their designs, selection and blinding procedures. Regarding the control of confounders, three studies received a strong rating for indicating the absence of any significant differences between groups in relation to sex, age, level of education, race, ethnicity (Da Silva et al. 2018, Rus-

Calafell et al. 2013, Minor et al. 2018). One was given a moderate EPHPP score as it controlled only gender as a confounding factor (Steinisch et al. 2011). The remaining three studies were rated as weak as they either did not mention any confounders in their analyses or only reported the overall sample characteristics without carrying out any between-group comparisons (Van Doorn et al. 2018, Vastano et al. 2014, García-Montes et al. 2014).

The majority of the studies, four out of seven, provided information regarding the numbers and reasons for withdrawals and drop-outs (Da Silva et al. 2018, Van Doorn et al. 2018, Vastano et al. 2014, Rus-Calafell et al. 2013). In all these studies, the completion rate was over 80%, which reflects the volunteering nature of the participation to the experiments. Three studies were given a “not applicable” mark for this domain, as they were either one-time surveys or did not report any dropouts or information about any people who refused to participate halfway through the task (Steinisch et al. 2011, García-Montes et al. 2014, Minor et al. 2018).

Table 2. EPHPP quality assessment ratings breakdown by six domains as well as the global rating of reviewed studies N=7

Authors	Title	Selection bias	Study design	Confounders	Blinding	Data collection Methods	Withdrawals and drops-outs	Global rating
Steinisch et al. (2011)	A virtual environment for egocentric and allocentric mental transformations: a study on a nonclinical population of adults with distinct levels of schizotypy	Weak	Weak	Moderate	Weak	Strong	Not applicable	Weak
Da Silva et al. (2018)	An Examination of the Multi-Faceted Motivation System in Healthy Young Adults	Weak	Weak	Strong	Weak	Strong	Strong	Weak
Van Doorn et al. (2018)	Down the rabbit hole: assessing the influence of schizotypy on the experience of the Barbie Doll Illusion	Weak	Weak	Weak	Weak	Strong	Strong	Weak
Vastano et al. (2014)	Embodied and disembodied allocentric simulation in high schizotypal subjects	Weak	Weak	Weak	Weak	Strong	Strong	Weak
García-Montes et al. (2014)	High and Low schizotypal female subjects do not differ in spatial memory abilities in a virtual reality task	Weak	Weak	Weak	Weak	Strong	Not applicable	Weak
Rus-Calafell et al. (2013)	Schizotypy, Alexithymia and Affect as predictors of Facial Emotion Recognition Capability using static and dynamic images	Weak	Weak	Strong	Weak	Strong	Strong	Weak
Minor et al. (2018)	Words Matter: Implementing the Electronically Activated Recorder in Schizotypy	Weak	Weak	Strong	Weak	Strong	Not applicable	Weak

3.3.5. Schizotypy questionnaires used in the studies

The assessment of schizotypy varied across studies: three studies (Van Doorn et al. 2018; Da Silvia et al. 2018; Minor et al. 2018) used the Likert-scale version (Wuthrich V. et al. 2005) of the Schizotypal Personality Questionnaire (SPQ) (Raine 1991), two studies (Steinisch et al. 2011; Vastano et al. 2014) used the Italian translation (Fossati A. et al 2003) of the SPQ (Raine 1991), one study (García-Montes et al. 2014) used the Oviedo Questionnaire for Schizotypy Assessment (ESQUIZO-Q-A) (Fonseca-Pedrero et al. 2012) and one study (Rus-Calafell et al. 2013) the Spanish adaptation of the Oxford-Liverpool Inventory of Feelings and Experiences-Reduced Version (O-LIFE-R; Spanish adaptation by Gutiérrez-Maldonado et al. 1999).

All studies received a strong rating for their data collection methods as all the schizotypy questionnaires were described as valid and reliable. Four studies (Minor et al. 2018; García-Montes et al. 2014; Vastano et al. 2014; Steinisch et al. 2011) explored the presence of any difference between high and low schizotypy groups in relation to the main researched paradigms. One study (Da Silva et al. 2018) looked in depth at the three different schizotypy domains e.g., positive, negative, and disorganised, as well as their correlation with reward-responsiveness. Van Doorn et al. (2018) placed particular emphasis on the cognitive-perceptual subscale of the positive schizotypy domain and its influence on individuals' levels of immersion in a virtual environment, whereas Rus-Calafell et al. (2013) explored the relationship of the schizotypy construct as a whole with alexithymia and affect.

3.3.6. Types of digital technology used

A wide range of DTs was adopted in the reviewed studies to assess and research different characteristics of healthy adult populations, who had also been screened for schizotypal personality (please refer to Table 1 page 19 for further details regarding the type of DTs used). The technology used varied from: electronic devices that needed to be worn, such as electronically activated recorders (EAR) (n=1) (Minor et al. 2018) to DTs that generated either immersive (n=2) (Van Doorn et al. 2018, Rus-Calafell et al. 2013) or non-immersive (n=4) (García-Montes et al. 2014; Vastano et al. 2014; Steinisch et al. 2011, Da Silva et al. 2018) virtual realities. None of the analyses

reviewed aimed at directly assessing the feasibility or safety of the DTs used as these had already been demonstrated.

One study (Minor et al. 2018) used wearables, such as EAR. This was an application that could be linked with smartphones or any other smart electronic device and it was used to capture a person's natural environment via audio-recordings. In Minor et al. (2018), EAR was incorporated in an iPod Touch, which participants had to wear for 2 consecutive days. The wearable made a series of audio-recordings at predetermined intervals, registering up to 2 hours of audio data for each participant. EAR has demonstrated test-retest reliability (Mehl et al. 2012).

Four studies displayed non-immersive virtual environments through flat screens (García-Montes et al. 2014; Vastano et al. 2014; Steinisch et al. 2011, Da Silva et al. 2018). Steinish et al. (2011) and Vastano et al. (2014) opted for a non-immersive virtual environment system, as they felt that it was sufficient for participants to understand the scene and adequately respond to the experiments which, they highlighted involved only the use of static images and non-moving objects, implying that a sense of immersion was not required. For these reasons both studies used an off-the-shelf monitor for task visualisation. Furthermore, the experiments were undertaken in a dark room in order to minimise distractions.

García-Montes et al. (2014) used a portable computer colour screen to present participants with a 3D virtual environment called "The Boxes Room" in which they were asked to navigate through different boxes placed in a room by using a joystick. Auditory feedback was given from the computer speaker. Likewise, volunteers who took part in Da Silva et al. (2018) research were shown a virtual reality task on a liquid-crystal display and allowed to provide input with either a keyboard or joystick.

In the remaining two studies, virtual environments were displayed through head mounted display (HMD) or 3D glasses. Van Doorn et al. (2018) used HMD to create an immersive environment which intended to allow participants to experience a body swap illusion by seeing the world from the perspective of a doll, whereas Rus-Calafell et al. (2013) used a laptop monitor and a stereoscopic view to present facial stimuli. Participants wore 3D glasses for the entire duration of the task. Authors explained that

this hardware was preferred over VR equipment, such as head mounted display (HMD), because of its portability and higher ergonomic features.

3.3.7. Characteristics assessed by digital technologies

On the whole these studies showed the versatile use of DTs in assessing and researching a wide range of features in healthy individuals with high schizotypy traits. To improve clarity, the characteristics investigated, and related findings have been grouped on the basis of the type of the DTs used. This information is summarised in Table 3.

Table 3. Samples' characteristics assessed through the use of digital technologies

Authors	Title	Characteristics assessed	Findings
Wearable devices			
Minor et al. (2018)	Words Matter: Implementing the Electronically Activated Recorder in Schizotypy	Whether positive, negative, or disorganised schizotypy personality traits differently correlate with affective disturbances or social engagement.	Findings gathered by EAR indicated that individuals with high schizotypy levels reported a greater frequency of negative effect words and demonstrated less social engagement when compared to low schizotypy. Same outcomes were recorded by the EMA. Overall, positive schizotypy traits predicted higher levels of negative affect. The evidence regarding the role of negative schizotypy in negative affect was limited. No significant data was found to conclude that disorganised schizotypy traits were linked to negative affect and/or poorer social engagement.
Non-Immersive Digital technology			
Steinisch et al. (2011)	A virtual environment for egocentric and allocentric mental transformations: a study on a nonclinical population of adults with distinct levels of schizotypy	The cognitive processes rooted in visual perspective taking and their association with schizotypy features and whether schizotypy traits effect an individual's perspective taking skills.	High schizotypy individuals were quicker across both allocentric mental transformations (the ability to encode information about the location of one object in relation to other objects) and in egocentric spatial processing (the ability to represent the location of an object in space in relation to the self) tasks when compared to low schizotypy. However, within group results showed that high schizotypy individuals were quicker in changing their own perspective by mentally moving to a position indicated by an inanimate object e.g., a chair, rather than taking the perspective of a virtual human being (avatar) by mentally moving to where it was located. The low schizotypy group did not follow a similar pattern.
Vastano et al. (2014)	Embodied and disembodied allocentric simulation in high schizotypal subjects	The relationship between schizotypy and allocentric spatial transformations, placing an emphasis on embodied and disembodied perspective taking.	The results supported the presence of disembodied allocentric deficits in high schizotypy when compared to the low schizotypy group. This confirmed the presence of a disconnection between perspective taking and perspective changing in high schizotypy individuals.
García-Montes et al. (2014)	High and Low schizotypal female subjects do not differ in spatial memory abilities in a virtual reality task	The presence of dissimilarities in spatial ability skills between high and low schizotypal female subjects.	Findings reported no significant differences between the two groups.
Da Silva et al. (2018)	An Examination of the Multi-Faceted Motivation System in Healthy Young Adults	Action selection and decision-making skills. Computerised tasks were used to explore the multi-dimensionality of motivation and reward system and whether there were any differences across schizotypy subgroups (positive, negative and disorganised) and depression symptoms.	With regard to schizotypy, findings showed that there weren't significant differences between the two cluster groups, which had been defined by using the k-means clustering algorithm. Correlational analyses demonstrated that reward responsiveness (the ability to experience pleasure in the anticipation and presence of reward-related stimuli) was negatively correlated to negative schizotypy, amotivation and depressive symptomatology. Moreover, schizotypy subgroups did not show any significant differences in relation to tasks assessing action selection and decision making.

Immersive Digital technologies			
Van Doorn et al. (2018)	Down the rabbit hole: assessing the influence of schizotypy on the experience of the Barbie Doll Illusion	To assess whether healthy individuals who scored high on the cognitive-perceptual schizotypy domain, were more liable to be influenced by a body swapping illusion task called the Barbie Doll Illusion	The results obtained reported the presence of a positive correlation between positive SPQ scores and immersion ratings, with the latter being higher in the body stimulation synchronous condition (both participant' and doll's right thighs were simultaneously stroked by the experimenter) than in the asynchronous (researcher stroked participants' right leg and doll's left leg at different times and in different directions).
Rus-Calafell et al. (2013)	Schizotypy, Alexithymia and Affect as predictors of Facial Emotion Recognition Capability using static and dynamic images	Facial emotional recognition skills and whether these were influenced by specific personality traits, such as schizotypy, alexithymia and negative affect.	The findings confirmed the presence of a positive correlation between alexithymia and schizotypy traits, and between schizotypy and negative affect.

Overall, the studies' findings in relation to schizotypy traits are in agreement with the descriptions of the personality features associated with each of its dimensions. Following the traditional classification of the schizotypy factors as positive, negative and disorganised, research has shown positive psychotic-like symptoms being associated with increased negative affect (Kwapil, et al. 2012, Husky, et al. 2004) and distortions in body representations (Germine et al. 2013, Lenzenweger, 2006): relationships also noted in Minor et al. (2018) and Van Doorn et al. (2018)'s studies. The findings highlighted in Van Doorn et al. (2018)'s analysis are in line with previous evidence, supporting the idea that individuals who score high on the positive schizotypy domain tend to experience higher perceptual distortions in respect to their body (Rado, 1960 and Meehl, 1964, cited Lenzenweger, 2000 page 112).

On the contrary, the negative schizotypy domain, characterised by constricted affect blunted affect (Fonseca-Pedrero et al. 2011), social anxiety and isolation, has been associated with a decrease of positive affect (PA), social interest and enjoyment from activities (Kwapil et al. 2012): a definition that explains the negative correlation between the reward responsiveness and amotivation described by Da Silva et al. (2018).

Furthermore, schizotypy has also been connected to facial emotion recognition deficits (Brown et al. 2010) and with poor mentalising. The former was explored by Rus-Calafell et al. (2013). Despite the study's findings highlighting a positive correlation between alexithymia and schizotypy traits, and between schizotypy and negative affect, statistical regression analysis did not support the explanation of schizotypy being associated with facial emotions recognition impairments as demonstrated in other studies (Dickey et al. 2011). Researchers questioned whether the lack of evidence gathered was due to the sample not being fully representative of the schizotypy population. With regards to the latter, some studies have described poor mentalising abilities to be a contributing factor to perspective taking impairments in schizotypy healthy adult (Langdon et al. 2001): deficits also noted by Steinish et al. (2011) and Vastano et al. (2014).

García-Montes et al. (2014) hypothesised that the lack of significant differences reported between groups were possibly due to the sample's schizotypy profile being on

what Raine (2006) describes as psychosocial trajectory rather than a neurodevelopmental one; meaning that the individuals' schizotypy traits were influenced more by psychosocial factors, e.g., impaired family environments rather than genetic ones e.g., heritable schizotypal features (Torgersen et al. 2000; Ericson et al. 2011) or brain structure alterations (Ettinger et al. 2012), such as hippocampal function abnormalities and therefore more difficult to capture.

3.3.8. Associations between schizotypy self-report measures and the constructs assessed using DTs

The associations between the schizotypy self-report questionnaires used in each study and the constructs, paradigms and tasks assessed through the implementation of DTs, are summarised below.

Minor et al. (2018) study mainly investigates groups' differences (low and high schizotypy) in relation to affective disturbances and social engagement, with high schizotypy reporting poorer social engagement and greater negative affect. Positive schizotypy demonstrated to be a significant predictor of greater negative affect, as measured by the EAR. None of the three schizotypy dimensions, positive, negative and disorganised were found to significantly predict social engagement. Furthermore, schizotypy was not found to moderate the relationship between affect and social engagement for positive affect and only partially for negative affect.

Da Silva (et al. 2018) used a VR errand-running task to assess participants' action selection and decision-making skills. The correlation analyses between these skills and the six self-report measures administered, which included the Likert-scale SPQ (Wuthrich et al. 2005), showed a significant negative correlation of the action selection and decision-making with the anticipatory pleasure subscale (TEPS-Ant) of the Temporal Experience of Pleasure Scale (Gard et al. 2006), but neither of the two skills correlated with the SPQ scores.

García-Montes (et al. 2014), reported statistically significant differences between the study groups (high and low schizotypy) in regard to the personality dimensions of reality distortion and interpersonal disorganisation, as measured by the ESQUIZO-Q-

A scale (Fonseca-Pedrero et al. 2012). No statistically significant differences were noted between groups in either the spatial memory acquisition or spatial memory recognition tasks. No correlation analyses were reported as only differences between groups were explored.

From the correlation analyses carried out by Steinish et al. (2011), it was noted that levels of schizotypy, as measured by the Italian translation of the SPQ (Fossati A. et al 2003), revealed statistically significant variances between groups (high and low schizotypy) in two of the three tasks included in the study; significant results were noted in the imagined rotation time phase and task time but not in the task accuracy. Similar findings were reported by Vastano et al. (2014) where levels of schizotypy, as measured by the same SPQ scale, had significant variances between groups (high and low schizotypy) in the imagined rotation time phase and task time, but not with the task accuracy. Furthermore, correlation analysis between the SPQ cognitive perceptual subscale scores and the task reaction times showed a significant positive correlation only in one of the six tasks undertaken by participants.

Van Doorn (et al. 2018) illustrated a positive correlation between 'touch type' and SPQ cognitive-perceptual schizotypy scores in the synchronous condition of the body swapping illusion. The result of this correlation was stronger ($r=.58$, $p<.001$) than those from the asynchronous condition ($r=.40$, $p=.008$). No statistically significant differences were noted for the second task of the study: estimation of cube size.

In Rus-Calafell (et al. 2013) study, the schizotypy construct as measured by the O-LIFE-R questionnaire (O-LIFE-R; Spanish adaptation by Gutiérrez-Maldonado et al. 1999) was not a significant predictor of poor performance in either the photograph or virtual reality facial emotion recognition tasks. Poor performance in the virtual reality task significantly correlated with self-reported alexithymia and with the total errors in the photograph facial emotion recognition task. Both correlations were positive.

The seven studies used different measurements to explore the presence of any association between self-report schizotypy and objective measures assessed using DTs. Two studies (Rus-Calafell et al. 2013; Da Silva et al. 2018) explored the relationship between self-reported schizotypy and other paradigms assessed by DTs. The remaining

five studies (Minor et al. 2018; Steinish et al. 2011, Vastano et al. 2014, García-Montes et al. 2014 and Van Doorn et al. 2018) investigated, as a primary outcome of interest, whether the variability in schizotypy scores between the different groups (low and high) were significant across various conditions or tasks, during which DTs were used to assess other paradigms. Out of these five studies, three studies (Minor et al. 2018; Van Doorn et al. 2018 and Vastano et al. 2014) also examined, as a secondary aim, the presence of an association between schizotypy scores and other constructs.

Overall, five studies (Rus-Calafell et al. 2013; Da Silva et al. 2018; Minor et al. 2018; Van Doorn et al. 2018 and Vastano et al. 2014) carried out correlation and predictive analyses, either as primary or secondary aims. They all reported partial or lack of associations between the self-reported schizotypy and the objective measures assessed using DTs.

It is also important to highlight that the lack of or poor association between schizotypy and the constructs assessed using DTs, could be due to some of the limitations associated with the type of DTs used and the way they were administered, which might have altered the accuracy with which the constructs assessed by the DTs was measured. Minor et al. (2018) reports that the use of wearable devices might have influenced observable behaviours by increasing participants' awareness of the EAR and therefore altered the accuracy of the participants' ratings. Rus-Calafell et al. (2013) questioned the reliability and efficiency of virtual reality for emotion recognition research, whereas Van Doorn et al. (2018) lists some technical limitations associated with the DT used which might have weakened the vividness of the illusion induced and therefore the sense of immersion experienced by participants. Da Silva et al. (2018) stated that the computerised measures of motivation utilised a wide range of intangible rewards, which might have contributed to failing to find any significant differences between tasks. Steinisch et al. (2011) acknowledged that they were the first to investigate the cognitive processes rooted in visual perspective using a virtual reality environment and wondered whether the discrepancy of their results with previous studies investigating the same constructs might be due to the different setups used (real vs. virtual environments and objects). García-Montes et al. (2014) and Vastano et al. (2014) were the only two studies that did not discuss the impact of the type of DTs used and how they were used

on the studies' results. Both studies attributed any difference noted in the results to the effects of schizotypy dimensions.

4. General discussion

The original aim of this review was to document the use of DTs as an assessment and/or research tool for schizotypal personality traits in healthy adult populations. In the reviewed literature, however, schizotypy was solely assessed through the administration of questionnaires, either in paper or electronic form. In light of this, the focus of this review shifted to summarise the results of available studies that used DTs to assess and research any characteristics in healthy adults who had also been assessed for schizotypy.

4.1. Main findings

This systematic review yielded heterogenous results in relation to the types of DTs used in healthy adults. Publication biases, study limitations and considerations about DTs used and their correlations with self-report measures, are discussed in the subsequent paragraphs.

4.1.1. Publications biases

Several biases have been identified in the reviewed studies that could have influenced the collection, analysis, interpretation and publication of their results. The selection procedures used, especially in those studies that recruited only voluntary groups or university students, may have increased the chances of yielding unrepresentative samples and reducing the generalisability of the studies' findings. This might be due to volunteers displaying characteristics that differ from those who do not spontaneously self-select into empirical investigations.

Another factor that may have influenced the representativeness of the studies' samples is the use of only specific platforms to advertise participants' recruitment e.g., students' noticeboards, social media outlets, local classified listing, student registries and university lecturers. This would have prevented researchers from reaching out to

diverse audiences with characteristics that might have been different from being highly educated, students and social-media users.

None of the studies clearly stated whether participants were aware of the research questions or whether they knew that they had been allocated to a specific group e.g., low or high schizotypy. Subjects could have altered their performance or behaviour as a result of being aware of the studies' hypotheses and of being observed. Participants reactivity threats, such as evaluation apprehension, experimenter effects and groups' awareness of its status, could have affected the studies' validity. Furthermore, the lack of blinding procedure could have led data collectors and outcome assessors to alter the participants' allocation to a specific group and the related data collection.

4.1.2. Associations between schizotypy self-reports measures and the constructs assessed using DTs

This review explored the associations between the self-report measures of schizotypy and the constructs, paradigms and tasks assessed using DTs in order to ascertain to what extent schizotypy, as assessed by self-report measures, has meaningful and/or predicted associations with the objective measures of cognition, affect and behaviour.

Overall the results outlined in paragraph 3.3.8. on page 33, illustrate that in most of the review studies the association between self-report schizotypy and the objective constructs assessed by using DTs, was limited or absent.

All studies used self-report questionnaires to evaluate schizotypy levels. It is known that self-report measures, such as questionnaires, measure the opinion of people about themselves over an extended period of time, whereas objective measures, such as DTs capture cognitions, affects and behaviours in 'real-time'. Although questionnaires measuring individual differences in personality predispositions are considered to measure stable traits, there may be state variations and/or fluctuations, which could be best captured using objective measures, such as DTs.

The subjective method (e.g., self-reported questionnaires) with which schizotypy was assessed may have altered the results outlined by correlation analyses and consequently, the conclusions draw upon whether a statistically significant relationship existed or not.

Self-report surveys are generally influenced by social desirability biases as participants may give socially desirable answers rather than truthful ones when answering questions that they may perceive as sensitive. Participants may also find it difficult to accurately assess themselves and they may interpret any technical and/or vague terminology included in the questionnaire subjectively, which may also alter the validity of the answers given.

Overall the preliminary findings suggest a limited or absent association between self-report schizotypy and the constructs objectively assessed using DTs. In order to further explore whether this partial or lack of association is due to the subjective method with which schizotypy has been assessed, DTs could be used to objectively improve the precision in evaluating a relationship between schizotypy and other constructs. The test-retest of the assessment of schizotypy traits using DTs could be a method to carry out such exploration and to ascertain the short- and long-term test-retest reliability of DTs in assessing schizotypy traits.

4.1.3. Digital technology and schizotypy

This review highlights a gap in research regarding the use of DT as an assessment and research tool to directly assess schizotypy traits. Taking into account the small available data in this field there is very limited evidence of the use of DTs in schizotypy healthy populations. Despite this limitation this review suggests immersive and non-immersive DTs to be feasible and safe tools to investigate a wide range of personality traits and skills in schizotypy healthy adults, but not to improve the rigor of the assessment of schizotypy. The schizotypy construct appears to be mainly measured through conventional paper questionnaires or their electronic versions.

Despite the limited or absent association between self-reported schizotypy and the objectively-assessed constructs using DTs in the seven reviewed studies, as discussed in paragraph 4.1.2. (page 37), it is important to highlight that the approach and technology used by Minor et al. (2018) demonstrated stronger positive correlations between schizotypy and the constructs assessed through the use of DTs, in comparison to the results of the other studies (Rus-Calafell et al. 2013; Da Silva et al. 2018; Van Doorn et al. 2018 and Vastano et al. 2014; García-Montes et al. 2014; Steinish et al.

2011). This might be due to the use of wearable devices, which were worn by individuals over a prolonged period of time, capturing more detailed data that might better reflect the complexity and nuances of schizotypal personality.

The use of wearable technology that allowed assessing schizotypal traits on multiple points has suggested that they are not as stable as the previous research using a single-point measurement with self-report questionnaires might indicate. This in itself is an important finding, worthy of further investigation, as it might have important implications in the context of monitoring schizotypal traits over time, particularly in the context of assessing risk factors for conversion to psychosis, such as suspiciousness/paranoia. The longitudinal measurements of schizotypal traits might be a more effective method for measuring the wide expression of schizotypal personality, including less stable traits, such as blunted affect, typically associated with the negative schizotypy domain, and for establishing any association between schizotypy and other constructs of interests.

In light of the extensive evidence describing schizotypy traits as a risk maker for schizophrenia-spectrum disorders (Racioppi et al. 2018), additional longitudinal empirical investigations aimed to explore further schizotypy traits through the use of objective assessment tool, such as VR and/or wearable devices may provide a better understanding of the psychological etiological mechanisms associated with each schizotypy domain and the trajectories of psychosis.

5. Limitations

A number of limitations for this systematic review should be considered: only articles published in English were screened, limiting the focus of this review to research written in or translated into English. No grey literature was included, which might have biased the review results. Manual searches were not carried out meaning that potential eligible articles might have been missed. The seven articles reviewed were all published between 2011 and 2018, which illustrates the novelty of the topic discussed and the limited information available. This review focused only on healthy adult groups; therefore, articles that used DTs in other populations, such as young adults and or children, who had also been assessed on schizotypal traits have not been included.

Furthermore, the quality assessment tool EPHPP used for this review contains fewer domains of appraisal when compared to others, such as Cochrane. It is therefore possible that the EPHPP is less sensitive to measuring the issues affecting the studies' internal and external validity, which, consequently, might have led to less accurate descriptions of the studies' risks of bias. The EPHPP also automatically assigns a strong score to studies that use a randomised control trial as experimental design, giving a weak score to those that do not. As none of the reviewed studies was a randomised control trial, it could be that their design methods have been assessed harshly without considering other factors.

Other quality assessment tools, such as GRADE give a provisional rate to the study design which is then down- or upgraded on the basis of the presence or absence of: imprecision, inconsistency, indirectness of the study results, and publication bias. In contrast, the EPHPP considers and rates some of these factors as separate independent domains, which increases the number of individual elements against which a studies' methodology is assessed. It is possible that the use of a different quality assessment tool, such as GRADE that condenses the domains regarding the study methodology to one single rating, might have improved the global rating given to some of the reviewed studies. A strength of this review is that it highlights a gap in research that could inform future studies.

6. Conclusions

Preliminary evidence suggests that a range of different technologies can be used to assess and research characteristics in samples of healthy adults who have also been screened for schizotypy personality traits. However, the limited research in this field, alongside the diverse DTs and approaches employed and the lack of studies investigating the use of DTs in directly assessing schizotypy personality traits, make it difficult to draw meaningful conclusions regarding the use of DT to investigate schizotypy. Further research is required to provide evidence of the effectiveness and feasibility of both immersive and non-immersive DTs in assessing and researching schizotypy personality traits in healthy populations.

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8. Declarations of Interest

None

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None

10. References

Andersson, G., Cuijpers, P., Carlbring, P., Riper, H, Hedman, E. (2014). Guided Internet-based vs. face-to-face cognitive behavior therapy for psychiatric and somatic disorders: a systematic review and meta-analysis. *World Psychiatry*, 13, 288-295.

Armijo-Olivo, S., Stiles, C. R., Hagen, N. a., Biondo, P. D., & Cummings, G. G. (2012). Assessment of study quality for systematic reviews: a comparison of the Cochrane Collaboration Risk of Bias Tool and the Effective Public Health Practice Project Quality Assessment Tool: methodological research. *Journal of Evaluation in Clinical Practice*, 18, 12–18.

Arnberg, F. K., Linton, S. J., Hultcrantz, M., Heintz, E., Jonsson, U. (2014). Internet-Delivered Psychological Treatments for Mood and Anxiety Disorders: A systematic Review of Their Efficacy, Safety, and Cost-Effectiveness, PLoS ONE, 9(*5*), 1-13.

Batra, S., Baker, R. A., Wang, T., Forma, F., DiBiasi, F., Peter-Strickland, T. (2017). Digital health technology for use in patients with serious mental illness: a systematic review of the literature. *Journal of Medical Devices,* 10, 237-251.

Ben-Zeev, D., Brenner, C. J., Begale, M., Duffecy, J., Mohr, D. C. and Mueser, K. T. (2014). Feasibility, Acceptability, and Preliminary Efficacy of a Smartphone Intervention for Schizophrenia. *Schizophrenia Bulletin*, 40(*6*), 1244-1253.

Berry, N., Lobban, F., Emsley, R., Bucci, S. (2016). Acceptability of Interventions Delivered Online and Through Mobile Phones for People Who Experience Severe Mental Health Problems: A Systematic Review. *Journal of Medical Internet Research,* 18(*5*), 1-15.

Bouchard, S., Dumoulin, S., Robillard, G., Guitard, T., Klinger, É., Forget, H., Loranger, C. and Roucaut, F. X. (2017). Virtual reality compared with in vivo exposure in the treatment of social anxiety disorder: a three-arm randomised controlled trial. *The British Journal of Psychiatry*, 210, 276-283.

Brown, L. L., and Cohen, A. S. (2010). Facial emotion recognition in schizotypy: The role of accuracy and social cognitive bias. *Journal of the International Neuropsychological Society,* 16, 474-483.

Carl, E., Stein, A. T., Levihn-Coon, A., Pogue, J. R., Rothbaum, B., Emmelkamp, P., Asmundson, G. J. G., Carlbring, P., Powers, M. B. (2019). Virtual reality exposure therapy for anxiety and related disorders: A meta-analysis of randomized controlled trials. *Journal of Anxiety Disorders*, 61, 27-36.

Carlbring, P., Andersson, G., Cuijpers, P., Riper, H. & Hedman-Lagerlöf, E. (2017). Internet-based vs. face-to-face cognitive behaviour therapy for psychiatric and somatic disorders: an updated systematic review and meta-analysis. *Cognitive Beahviour Therapy,* 47(*1*), 1-18.

Carlbring, P., Bohman, S., Brunt, S., Buhrman, M., Westling, B. E., Ekselius, L., Andersson, G. (2006). Remote Treatment of Panic Disorder: A Randomized Trial of Internet-Based Cognitive Beahavior Therapy Supplemented With Telephone Calls. *American Journal of Psychiatry,* 163, 2119-2125.

Claridge, G. (1997). *Schizotypy: implications for Illness and Health*. Oxford University Press.

Claridge, G., Beech, T. (1995). Fully and quasi-dimensional constructions of schizotypy. In: Raine, A., Lencz, T., Mednick, S.A. (Eds.), *Schizotypal Personality*. Cambridge University Press, Cambridge, 192–216.

Da Silva, S., Apatsidou, A., Saperia, S., Siddiqui, I., Jeffay, E., Voineskos, A. N., Daskalakis, Z. J., Remington, G., Zakzanis, K. K., and Foussias, G. (2018). An Examination of the Multi-Faceted Motivation System in Healthy Young Adults. *Frontiers in Psychiatry,* 9(*191*), 1-10.

Debbané, M., Eliez, S., Badoud, D., Conus, P., Flückiger, R., & Schultze-Lutter, F. (2014). Developing psychosis and its risk states through the lens of schizotypy. *Schizophrenia bulletin*, 41, 396-407.

Dickey, C. C., Panych, L. P., Voglmaier, M. M., Niznikiewicz, M. A., Terry, D. P., Murphy, C., Zacks, R., Shenton, M. E., McCarley, R. W. (2011). Facial Emotion Recognition and Facial Affect Display in Schizotypal Personality Disorder. *Schizophrenia Research*, 131(*1-3*), 242-249.

Ericson, M., Tuvblad, C., Raine, A., Young-Wolff, K. and Baker, L. A. (2011). Heritability and Longitudinal Stability of Schizotypy Traits During Adolescence. *Behavior Genetics*, 41, 499-511.

Ettinger, U., Williams, S. C. R., Meisenzahl, E. M., Möller, H.-J., Kumari, V. & Koutsouleris, N. (2010). Association between brain structure and psychometric schizotypy in healthy individuals. *The World Journal of Biological Psychiatry*, 13(*7*), 544-549.

Fairburn, C. G., Patel, V. (2016). The impact of digital technology on psychological treatments and their dissemination. *Behaviour Research and Therapy*, 88, 19-25.

Firth, J., Torous, J. (2015). Smartphone Apps for Schizophrenia: A Systematic Review. *JMIR mHealth and uHealth*, 3*(4)*, 1-9.

Fonseca-Pedrero, E., Lemos-Giráldez, S., Mercedes, P., Santarén-Rosell, M., Sierra-Baigrie, S., and Muñiz, J. (2012). Reliability and Sources of Validity Evidence of the Oviedo Schizotypy Assessment Questionnarie-Abbreviated (ESQUIZO-Q-A). *The Spanish Journal of Psychology*, 15*(2)*, 840-849.

Fonseca-Pedrero, E., Mercedes, P., Lemos-Giraldez, S., Sierra-Baigrie, S., Muñiz (2011). Measurement invariance of the Schizotypal Personality Questionnaire-Brief across gender and age. *Psychiatry Research*, 190(*2-3*), 309-315.

Fossati, A., Feeney, J. A., Donati, D., Donini, M., Novella, L., Bagnato, M., Carretta, I., Leonardi, B., Mirabelli, S., Maffei C. (2003). Personality disorders and adult attachment dimensions in a mixed psychiatric sample: a multivariate study. *The Journal of Nervous and Mental Disease*, 191, 30–37.

Freeman, D., Garety, P. A., Bebbington, P., Slater, M., Kuipers, E., Fowler, D., Green, C., Jorndan, J., Ray, K. and Dunn, G. (2005). The Psychology of Persecutory Ideation II A Virtual Reality Experimental Study. *Journal of Nervous and Mental Disease,* 193, 309-315.

Freeman, D., Reeve, S., Robinson, A., Ehlers, A. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological Medicine,* 47*(14)*, 2391-2400.

Freeman, D., Slater, M., Bebbington, P. E., Garety, P. A., Kuipers, E., Fowler, D., Met, A., Read, C. M., Jordan, J. and Vinayagamoorthy, V. (2003). Can Virtual Reality be Used to Investigate Persecutory Ideation? *The Journal of Nervous and Mental Disease,* 191(*8*), 509-514.

García-Montes, J. M., Noguera, C., Álvarez, D., Ruiz, M., & Cimadevilla Redondo, J. M. (2014). High and low schizotypal female subjects do not differ in spatial memory abilities in a virtual reality task. *Cognitive Neuropsychiatry*, 19(*5*), 427-438.

Garcia-Palacios, A., Hoffman, H., Carlin, A., Furness III, T. A., Botella, C. (2002). Virtual Reality in the treatment of spider phobia: a controlled study. *Behaviour Research and Therapy*, 40(*9*), 983-993.

Germine, L., Benson, T. L., Cohen, F., I'Lee Hooker, C. (2013). Psychosis-proneness and the rubber hand illusion of body ownership. *Psychiatry Research*, 207, 45-52.

Griffiths, K. M. G., Farrer, L., and Christensen, H. (2010). The efficacy of internet interventions for depression and anxiety disorders: a review of randomised controlled trials. *Medical Journal of Australia,* 192, 4-11.

Gutiérrez-Maldonado, J., Barrantes-Vidal, N., Obiols, J., Aguilar-Alonso, A., & Aguilar-Mediavilla, E. (1999). Versión reducida del Oxford-Liverpool Inventory of Feelings and Experiencies. Paper presented at the Fifth Conference on Psychological Assessment, Benalmádena, Málaga.

Hollis, C., Morriss, R., Martin, J., Amani, S., Cotton, R., Denis, M. and L., Shôn (2015). Technological innovation in mental healthcare: harnessing the digital revolution. *The British Journal of Psychiatry*, 206, 263-265.

Husky, M. M., Grondin, O. S., Swendsen, J. D., (2004). The relation between social behaviour and negative affect in psychosis-prone inviduals: an experience sampling investigation. *European Psychiatry*, 19, 1-7.

Jackson, N., and Waters, E. (2005). Criteria for the systematic review of health promotion and public health interventions. *Health Promotion International*, 20, 367–374.

Kane, I., Lee, H., Sereika, S. (2012). Feasibility of pedometers for adults with schizophrenia: pilot study. *Journal of Psychiatric and Mental Health Nursing*, 19(*1*), 8-14.

Kuester, A., Niemeyer, H., Knaevelsrud, C. (2016). Internet-based interventions for posttraumatic stress: A meta-analysis of randomized controlled trials. *Clinical Psychology Review,* 43, 1-16.

Kwapil, T. R., Barrantes-Vidal, N., & Silva, P. J. (2008). The dimensional structure of the Wisconsin Schizotypy Scales: Factor identification and construct validity. *Schizophrenia Bulletin,* 34, 444 – 457.

Kwapil, T. R., Gross, G. M., Silvia, P. J., & Barrantes-Vidal, N. (2013). Prediction of psychopathology and functional impairment by positive and negative schizotypy in the Chapmans' ten-year longitudinal study. *Journal of Abnormal Psychology*, 122(*3*), 807.

Kwapil, T., Silvia, P. J., Horton, L. E., Myin-Germeys, I. (2012). The expression of positive and negative schizotypy in daily life: An experience sampling study. *Psychological Medicine,* 42(*12*), 2555-2566.

Langdon, R., Coltheart, M. (2001), Visual perspective-taking and schizotypy: evidence for a simulation-based account of mentalizing in normal adults. *Cognition*, 82, 1–26.

Lenzenweger, M. F. (2000). Two-point discrimination thresholds and schizotypy: illuminating a somatosensory dysfunction. *Schizophrenia Research*, 42, 111-124.

Lenzenweger, M. F. (2006). Schizotypy: An Organizing Framework for Schizophrenia Research. *Association for Psychological Science,* 15(*4*), 162-166.

Linscott, R. J., van Os, J. (2010). Categorical versus continuum models in psychosis: evidence for discontinuous subpopulations underlying a psychometric continuum. Implications for DSM-V, DSM-VI, and DSM-VII. *Annual Review of Clinical Psychology*, 6, 391–419.

Macias, C., Panch, T., Hicks, Y. M., Scolnick, J. S., Weene, D. L., Öngür, D., Cohen, B. M. (2015). Using Smartphone Apps to Promote Psychiatric and Physical Well-Being. *Psychiatric Quarterly*, 86(*4*), 505-519.

Mason, O. J. (2015). The Assessment of Schizotypy and Its Clinical Relevance. *Schizophrenia Bulletin,* 41(*2*), 374-385.

Mehl, R. M., Robbinds, M. L., große Deters, F. (2012). Naturalistic Observation of Health-Relevant Social Processes: The Electronically Activated Recorder (EAR) Methodology in Psychosomatics. *Psychosomatic Medicine*, 74(*4*), 410-417.

Minor, K. S., Davis, J. B., Marggraf, M. P., Luther, L., Robbins, M. L. (2018). Words Matter: Implementing the Electronically Activated Recorder in Schizotypy. *Personality Disorders: Theory, Research and Treatment*, 9(*2*), 133-143.

Montes, J. M., Medina, E., Gomez-Beneyto, M., Maurino, J. (2012). A short message service (SMS)-based strategy for enhancing adherence to antipsychotic medication in schizophrenia. *Psychiatry Research*, 200(*2-3*), 89-95.

Mühlberger, A., Wiedemann, G., Pauli, P. (2003). Efficacy of a one-session virtual reality exposure treatment for fear of flying. *Psychotherapy Research*, 13(*3*), 323-336.

Naslund, J. A., Aschbrenner, K. A., Aray R., Marsch, L. A., Unützer, J., Patel, V. and Bartels, S. J. (2015c). Digital Technology for treating and preventing mental disorders in low-income and middle-income countries: a narrative review of the literature. *Lancet Psychiatry,* 4(*6*), 486-500.

Naslund, J. A., Aschbrenner, K. A., Barre, L. K., Bartels, S. J. (2015b). Feasibility of popular m-Health technologies for activity tracking among individuals with serious mental illness. *Telemedicine and e-Health*, 21(*3*), 213-216.

Naslund, J.A., Marsch, L.A., McHugo, G.J., Bartels, S.J. (2015a). Emerging mHealth and eHealth interventions for serious mental illness: a review of the literature. *Journal of Mental Health*, 24*(5)*, 321-332.

Neuvo, R., Chatterji, S., Verdes, E., Naidoo, N., Arango, C., Ayuso-Mateos, J. L. (2012). The continuum of psychotic symptoms in the general population: a cross-national study. *Schizophrenia Bulletin*, 38(*3*), 475–485.

NHS. Five Year Forward View for Mental Health: One Year On (2017, February). Retrieved from https://www.england.nhs.uk/wp-content/uploads/2017/03/fyfv-mh-one-year-on.pdf

NHS. Implementing the Five Year Forward View For Mental Health (2016, July). Retrieved from https://www.england.nhs.uk/wp-content/uploads/2016/07/fyfv-mh.pdf

O'Dea, S. (2019, November 27). Smartphone ownership in the United Kingdom (UK) 2012-2019, by age. Retrieved from https://www.statista.com/statistics/271851/smartphone-owners-in-the-united-kingdom-uk-by-age/

Office for National Statistics (2018). Internet access – households and individuals, Great Britain: 2018. Retrieved from https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/bulletins/internetaccesshouseholdsandindividuals/2018

Racioppi A., Sheinbaum, T., Gross, G. M., Ballespí, S., Kwapil, T. R., Barrantes-Vidal, N. (2018). Prediction of prodromal symptoms and schizophrenia-spectrum personality disorder traits by positive and negative schizotypy: A 3-year prospective study. *PLoS ONE,* 13(*11*), 1-18.

Raine, A. (1991). The SPQ: A Scale for the Assessment of Schizotypal Personality Based on DSM-III-R Criteria. *Schizophrenia Bulletin*, 17*(4)*, 555-564.

Raine, A. (2006). SCHIZOTYPAL PERSONALITY: Neurodevelopmental and Psychosocial Trajectories. Annual review Clinical Psychology, 2, 291-326.

Reger, G. M., Koenen-Woods, P., Zetocha, K., Smolenski, D. J., Holloway, K. M., Rothbaum, B. O., Difede, J., Rizzo, A. A., Edwards-Stewart, A., Skopp, N. A., Mishkind, M., Reger, M. A., Gahm, G. A. (2016). Randomized Controlled Trial of Prolonged Exposure Using Imaginal Exposure vs Virtual Reality Exposure in Active Duty Soldiers With Deployment-Related Postrtraumatic Stress Disoder (PTSD). *Journal of Consulting and Clinical Psychology*, 1-14.

Repetto, C., Gaggioli, A., Pallavicini, F., Cipresso, P., Raspelli, S. & Riva, G. (2011). Virtual reality and mobile phone in the treatment of generalised anxiety disorders: a phase-2 clinical trial. *Personal and Ubiquitous Computing,* 17, 253-260.

Riches, S., Garety, P., Rus-Calafell, M., Stahl, D., Evans, C., Sarras, N., Yeboah, K., Valmaggia, L. (2019). Using Virtual Reality to Assess Associations Between Paranoid Ideation and Components of Social Performance: A Pilot Validation Study. *Cyberpsychology, Behavior, and Social Networking,* 22(*1*), 51-59.

Rothbaum, B. O., Hodges, L. F., Kooper, R., Opdyke, D., Williford, J. S. and North, M. (1995). Effectiveness of computer-generated (virtual reality) graded exposure in the treatment of acrophobia. *American Journal of Psychiatry*, 152(*4*), 626-628.

Rus-Calafell, M., Garety, P., Sason, E., Craig, T. J. K., Valmaggia, L. R. (2018). Virtual reality in the assessment and treatment of psychosis: a systematic review of its utility, acceptability and effectiveness. *Psychological Medicine*, 48(*3*), 362-391.

Rus-Calafell, M., Gutiérrez-Maldonado, J., Frerich, N. (2013). Schizotypy, Alexithymia and Affect as predictors of Facial Emotion Recognition Capability using static and dynamic images. *Anuario de Psychología/The UB Journal of Psychology*, 43(*1*), 7-21.

Stefanis, N. C., Hanssen, M., Smirnis, N. K., Avramopoulos, D. A., Evdokimidis, I. K., Stefanis, C. N., Verdoux, H. and Van Os, J. (2002). Evidence that three dimensions of psychosis have a distribution in general population. *Psychological Medicine,* 32, 347-358.

Steinisch, M., Sulpizio, V., Iorio, A. A., Di Naccio, A., Haueisen, J., Committeri, G., and Comani, S. (2011). A virtual environment for egocentric and allocentric mental transformations: a study on a nonclinical population of adults with distinct levels of schizotypy. *Biomed Tech*, 56, 291-299.

Thomas, B. H., Ciliska, D., Dobbins, M., & Micucci, S. (2004). A process for systematically reviewing the literature: Providing the research evidence for public health nursing interventions. *World-views on Evidence-Based Nursing / Sigma Theta Tau International, Honor Society of Nursing*, 1, 176–184.

Torgersen, S., Lygrenm, S., Øien, P. A., Skre, I., Onstad, S., Edvardsen, J., Tambs, K., Kringlen, E. (2000). A twin study of personality disorders. *Comprehensive Psychiatry*, 41(*6*), 416-425.

Torous, J., Wisniewski, H., Liu, G., Keshavan, M. (2018). Mental Health Mobile Phone Usage, Concerns and Benefits Among Psychiatric Outpatients: Comparative Survey Study. *Journal of Medical Internet Research Mental Health*, 5(*4*), 1-11.

Valmaggia, L. R., Day, F., Rus-Calafell, M. (2016a). Using virtual reality to investigate psychological processes and mechanisms associated with the onset and maintenance of psychosis: a systematic review. *Social Psychiatry and Psychiatric Epidemiology,* 51,921-936.

Valmaggia, L., Freeman, D., Green, C., Garety, P., Swapp, D., Antley, A., Prescott, C., Fowler, D., Kuipers, E., Bebbington, P., Slater, M., Broome, M. and McGuire,

P. K. (2007). Virtual reality and paranoid ideations in people with an ‘at-risk mental state” for psychosis. *British Journal of Psychiatry,* 191(*52*),63-68.

Valmaggia, L., Latif, L., Kempton, M. L., Rus-Calafell, M. (2016b). Virtual reality in the psychological treatment for mental health problems: An systematic review of recent evidence. *Psychiatric Research*, 236, 189-95.

Van Doorn, G., De Foe, A., Wood, A., Wagstaff, D., Hohwy, J. (2018). Down the rabbit hole: assessing the influence of schizotypy on the experience of the Barbie Doll Illusion. *Cognitive Neuropsychiatry*, 23(*5*), 284-298.

van Os, J., Linscott, R. J., Myin-Germeys, I., Delespaul, P., Krabbendam, L. (2009). A systematic review and meta-analysis of the psychosis continuum: evidence for a psychosis proneness–persistence–impairment model of psychotic disorder. *Psychological Medicine*, 39(*2*), 179–195.

Vastano, R., Sulpizio, V., Steinisch, M., Comani, S., Committeri, G. (2014). Embodied and disembodied allocentric simulation in high schizotypal subjects. *Experimental Brain Research*, 232, 3023-3033.

Wagner, B., Horn, A. B., Maercker A. (2014). Internet-based versus face-to-face cognitive-bahvioural intervention for depression: A randomized controlled non-inferiority trial. *Journal of Affective Disorders*, 152-154, 113-121.

Wuthrich V., Bates, T. C. (2005). Reliability and validity of two Likert versions of the Schizotypal Personality Questionnaire (SPQ). *Personality and Individual Differences*, 38, 1543-1548.

11.Appendix I Search Strategy

OvidSP Search Strategy

1	virtual real*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
2	teleme*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
3	telemedicine.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
4	telepsych*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
5	telehealth*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
6	eHealth.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
7	mHealth.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
8	"mobile phone*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
9	"mobile health".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
10	"mobile tech*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
11	"mobile app*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
12	smartphone*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
13	internet.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
14	online.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
15	"online system*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
16	"social media".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
17	"Web-based intervention*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
18	"augmented real*".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
19	e-learning.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
20	computer*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
21	"computer assisted therapy".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
22	app*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
23	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22
24	schizoty*.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
25	"psycho*-proneness".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
26	"psycho*-prone".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
27	"psycho* prone personality".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
28	"psychotic-like".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
29	"psychosis-like".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]

30	24 or 25 or 26 or 27 or 28 or 29
31	23 and 30
28	"psychotic-like".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
29	"psychosis-like".mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy, tc, id, tm, mh]
30	24 or 25 or 26 or 27 or 28 or 29
31	23 and 30

Web of Science Search Strategy

Web of Science Core Collection 1900-2019

Results	**TOPIC:** ((virtual real* OR teleme* OR telemedicine OR telepsych* OR telehealth* OR eHealth OR mHealth OR “mobile phone*" OR "mobile health" OR "mobile tech*" OR "mobile app*" OR smartphone* OR internet OR online OR "online system*" OR "social media" OR "Web-based intervention*" OR "augmented real*" OR e-learning OR computer* OR "computer assisted therapy” OR app*)) *AND* **TOPIC:** ((schizoty* OR "psycho*-proneness” OR "psycho*-prone" OR "psycho* prone personality” OR "psychotic-like" OR "psychosis-like"))
1386	*Databases= WOS, BCI, KJD, MEDLINE, RSCI, SCIELO Timespan=All years*
	Search language=English

12.Appendix II Search results by database

Table 4. Database search results

Database	**Articles in English**
PsyINFO 1806 to March Week 4 2019	1558
Embase 1974 to March week 4 2019	1656
Ovid 1946 to March 31, 2019	1184
Web of science Core Collection 1900 to 2019	1386
Total articles	5784
Total after deduplication function used in Endnote	2576
Total articles for screening	3208

13.Appendix III Quality assessment tool

Quality Assessment Tool for Quantitative Studies Dictionary

The purpose of this dictionary is to describe items in the tool thereby assisting raters to score study quality. Due to under-reporting or lack of clarity in the primary study, raters will need to make judgements about the extent that bias may be present. When making judgements about each component, raters should form their opinion based upon information contained in the study rather than making inferences about what the authors intended. Mixed methods studies can be quality assessed using this tool with the quantitative component of the study.

A) SELECTION BIAS

(Q1) Participants are more likely to be representative of the target population if they are randomly selected from a comprehensive list of individuals in the target population (score very likely). They may not be representative if they are referred from a source (e.g. clinic) in a systematic manner (score somewhat likely) or self-referred (score not likely).

(Q2) Refers to the % of subjects in the control and intervention groups that agreed to participate in the study before they were assigned to intervention or control groups.

B) STUDY DESIGN

In this section, raters assess the likelihood of bias due to the allocation process in an experimental study. For observational studies, raters assess the extent that assessments of exposure and outcome are likely to be independent. Generally, the type of design is a good indicator of the extent of bias. In stronger designs, an equivalent control group is present and the allocation process is such that the investigators are unable to predict the sequence.

Randomized Controlled Trial (RCT)
An experimental design where investigators randomly allocate eligible people to an intervention or control group. A rater should describe a study as an RCT if the randomization sequence allows each study participant to have the same chance of receiving each intervention and the investigators could not predict which intervention was next. If the investigators do not describe the allocation process and only use the words 'random' or 'randomly', the study is described as a controlled clinical trial.

See below for more details.

Was the study described as randomized?

Score YES, if the authors used words such as random allocation, randomly assigned, and random assignment.

Score NO, if no mention of randomization is made.

Was the method of randomization described?

Score YES, if the authors describe any method used to generate a random allocation sequence.

Score NO, if the authors do not describe the allocation method or describe methods of allocation such as alternation, case record numbers, dates of birth, day of the week, and any allocation procedure that is entirely transparent before assignment, such as an open list of random numbers of assignments.
If NO is scored, then the study is a controlled clinical trial.

Was the method appropriate?

Score YES, if the randomization sequence allowed each study participant to have the same chance of receiving each intervention and the investigators could not predict which intervention was next. Examples of appropriate approaches include assignment of subjects by a central office unaware of subject characteristics, or sequentially numbered, sealed, opaque envelopes.

Score NO, if the randomization sequence is open to the individuals responsible for recruiting and allocating participants or providing the intervention, since those individuals can influence the allocation process, either knowingly or unknowingly.

If NO is scored, then the study is a controlled clinical trial.

Controlled Clinical Trial (CCT)
An experimental study design where the method of allocating study subjects to intervention or control groups is open to individuals responsible for recruiting subjects or providing the intervention. The method of allocation is transparent before assignment, e.g. an open list of random numbers or allocation by date of birth, etc.

Cohort analytic (two group pre and post)
An observational study design where groups are assembled according to whether or not exposure to the intervention has occurred. Exposure to the intervention is not under the control of the investigators. Study groups might be non-equivalent or not comparable on some feature that affects outcome.

Case control study
A retrospective study design where the investigators gather 'cases' of people who already have the outcome of interest and 'controls' who do not. Both groups are then questioned or their records examined about whether they received the intervention exposure of interest.

Cohort (one group pre + post (before and after)
The same group is pretested, given an intervention, and tested immediately after the intervention. The intervention group, by means of the pretest, act as their own control group.

Interrupted time series
A study that uses observations at multiple time points before and after an intervention (the 'interruption'). The design attempts to detect whether the intervention has had an effect significantly greater than any underlying trend over time. Exclusion: Studies that do not have a clearly defined point in time when the intervention occurred and at least three data points before and three after the intervention

Other:
One time surveys or interviews

C) CONFOUNDERS

By definition, a confounder is a variable that is associated with the intervention or exposure and causally related to the outcome of interest. Even in a robust study design, groups may not be balanced with respect to important variables prior to the intervention. The authors should indicate if confounders were controlled in the design (by stratification or matching) or in the analysis. If the allocation to intervention and control groups is randomized, the authors must report that the groups were balanced at baseline with respect to confounders (either in the text or a table).

D) BLINDING

(Q1) Assessors should be described as blinded to which participants were in the control and intervention groups. The purpose of blinding the outcome assessors (who might also be the care providers) is to protect against detection bias.

(Q2) Study participants should not be aware of (i.e. blinded to) the research question. The purpose of blinding the participants is to protect against reporting bias.

E) DATA COLLECTION METHODS

Tools for primary outcome measures must be described as reliable and valid. If 'face' validity or 'content' validity has been demonstrated, this is acceptable. Some sources from which data may be collected are described below:

Self reported data includes data that is collected from participants in the study (e.g. completing a questionnaire, survey, answering questions during an interview, etc.).

Assessment/Screening includes objective data that is retrieved by the researchers. (e.g. observations by investigators).

Medical Records/Vital Statistics refers to the types of formal records used for the extraction of the data.

Reliability and validity can be reported in the study or in a separate study. For example, some standard assessment tools have known reliability and validity.

F) WITHDRAWALS AND DROP-OUTS

Score **YES** if the authors describe BOTH the numbers and reasons for withdrawals and drop-outs.

Score **NO** if either the numbers or reasons for withdrawals and drop-outs are not reported.

Score **NOT APPLICABLE** if the study was a one-time interview or survey where there was not follow-up data reported.

The percentage of participants completing the study refers to the % of subjects remaining in the study at the final data collection period in all groups (i.e. control and intervention groups).

G) INTERVENTION INTEGRITY

The number of participants receiving the intended intervention should be noted (consider both frequency and intensity). For example, the authors may have reported that at least 80 percent of the participants received the complete intervention. The authors should describe a method of measuring if the intervention was provided to all participants the same way. As well, the authors should indicate if subjects received an unintended intervention that may have influenced the outcomes. For example, co-intervention occurs when the study group receives an additional intervention (other than that intended). In this case, it is possible that the effect of the intervention may be over-estimated. Contamination refers to situations where the control group accidentally receives the study intervention. This could result in an under-estimation of the impact of the intervention.

H) ANALYSIS APPROPRIATE TO QUESTION

Was the quantitative analysis appropriate to the research question being asked?

An intention-to-treat analysis is one in which all the participants in a trial are analyzed according to the intervention to which they were allocated, whether they received it or not. Intention-to-treat analyses are favoured in assessments of effectiveness as they mirror the noncompliance and treatment changes that are likely to occur when the intervention is used in practice, and because of the risk of attrition bias when participants are excluded from the analysis.

Component Ratings of Study:

For each of the six components A – F, use the following descriptions as a roadmap.

A) SELECTION BIAS

Good: The selected individuals are very likely to be representative of the target population (Q1 is 1) **and** there is greater than 80% participation (Q2 is 1).

Fair: The selected individuals are at least somewhat likely to be representative of the target population (Q1 is 1 or 2); **and** there is 60 - 79% participation (Q2 is 2). 'Moderate' may also be assigned if Q1 is 1 or 2 and Q2 is 5 (can't tell).

Poor: The selected individuals are not likely to be representative of the target population (Q1 is 3); **or** there is less than 60% participation (Q2 is 3) **or** selection is not described (Q1 is 4); and the level of participation is not described (Q2 is 5).

B) DESIGN

Good: will be assigned to those articles that described RCTs and CCTs.

Fair: will be assigned to those that described a cohort analytic study, a case control study, a cohort design, or an interrupted time series.

Weak: will be assigned to those that used any other method or did not state the method used.

C) CONFOUNDERS

Good: will be assigned to those articles that controlled for at least 80% of relevant confounders (Q1 is 2); **or** (Q2 is 1).

Fair: will be given to those studies that controlled for 60 – 79% of relevant confounders (Q1 is 1) **and** (Q2 is 2).

Poor: will be assigned when less than 60% of relevant confounders were controlled (Q1 is 1) **and** (Q2 is 3) **or** control of confounders was not described (Q1 is 3) **and** (Q2 is 4).

D) BLINDING

Good: The outcome assessor is not aware of the intervention status of participants (Q1 is 2); **and** the study participants are not aware of the research question (Q2 is 2).

Fair: The outcome assessor is not aware of the intervention status of participants (Q1 is 2); **or** the study participants are not aware of the research question (Q2 is 2).

Poor: The outcome assessor is aware of the intervention status of participants (Q1 is 1); **and** the study participants are aware of the research question (Q2 is 1); **or** blinding is not described (Q1 is 3 and Q2 is 3).

E) DATA COLLECTION METHODS

Good: The data collection tools have been shown to be valid (Q1 is 1); **and** the data collection tools have been shown to be reliable (Q2 is 1).

Fair: The data collection tools have been shown to be valid (Q1 is 1); **and** the data collection tools have not been shown to be reliable (Q2 is 2) **or** reliability is not described (Q2 is 3).

Poor: The data collection tools have not been shown to be valid (Q1 is 2) **or** both reliability and validity are not described (Q1 is 3 and Q2 is 3).

F) WITHDRAWALS AND DROP-OUTS - a rating of:

Good: will be assigned when the follow-up rate is 80% or greater (Q1 is 1 and Q2 is 1).

Fair: will be assigned when the follow-up rate is 60 – 79% (Q2 is 2) **OR** Q1 is 4 or Q2 is 5.

Poor: will be assigned when a follow-up rate is less than 60% (Q2 is 3) or if the withdrawals and drop-outs were not described (Q1 is No or Q2 is 4).

Not Applicable: if Q1 is 4 or Q2 is 5.

QUALITY ASSESSMENT TOOL FOR QUANTITATIVE STUDIES

COMPONENT RATINGS

A) SELECTION BIAS

(Q1) Are the individuals selected to participate in the study likely to be representative of the target population?

1 Very likely
2 Somewhat likely
3 Not likely
4 Can't tell

(Q2) What percentage of selected individuals agreed to participate?

1 80 - 100% agreement
2 60 – 79% agreement
3 less than 60% agreement
4 Not applicable
5 Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

B) STUDY DESIGN

Indicate the study design

1 Randomized controlled trial
2 Controlled clinical trial
3 Cohort analytic (two group pre + post)
4 Case-control
5 Cohort (one group pre + post (before and after))
6 Interrupted time series
7 Other specify _____
8 Can't tell

Was the study described as randomized? If NO, go to Component C.

No Yes

If Yes, was the method of randomization described? (See dictionary)

No Yes

If Yes, was the method appropriate? (See dictionary)

No Yes

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

C) CONFOUNDERS

(Q1) Were there important differences between groups prior to the intervention?

1 Yes
2 No
3 Can't tell

The following are examples of confounders:

1 Race
2 Sex
3 Marital status/family
4 Age
5 SES (income or class)
6 Education
7 Health status
8 Pre-intervention score on outcome measure

(Q2) If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?

1 80 – 100% (most)
2 60 – 79% (some)
3 Less than 60% (few or none)
4 Can't Tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

D) BLINDING

(Q1) Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?

1 Yes
2 No
3 Can't tell

(Q2) Were the study participants aware of the research question?

1 Yes
2 No
3 Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

E) DATA COLLECTION METHODS

(Q1) Were data collection tools shown to be valid?

1 Yes
2 No
3 Can't tell

(Q2) Were data collection tools shown to be reliable?

1 Yes
2 No
3 Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

F) WITHDRAWALS AND DROP-OUTS

(Q1) Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?

1 Yes
2 No
3 Can't tell
4 Not Applicable (i.e. one time surveys or interviews)

(Q2) Indicate the percentage of participants completing the study. (If the percentage differs by groups, record the lowest).

1 80 -100%
2 60 - 79%
3 less than 60%
4 Can't tell
5 Not Applicable (i.e. Retrospective case-control)

RATE THIS SECTION	STRONG	MODERATE	WEAK	
See dictionary	1	2	3	Not Applicable

G) INTERVENTION INTEGRITY

(Q1) What percentage of participants received the allocated intervention or exposure of interest?

1 80 -100%
2 60 - 79%
3 less than 60%
4 Can't tell

(Q2) Was the consistency of the intervention measured?

1 Yes
2 No
3 Can't tell

(Q3) Is it likely that subjects received an unintended intervention (contamination or co-intervention) that may influence the results?

4 Yes
5 No
6 Can't tell

H) ANALYSES

(Q1) Indicate the unit of allocation (circle one)

community organization/institution practice/office individual

(Q2) Indicate the unit of analysis (circle one)

community organization/institution practice/office individual

(Q3) Are the statistical methods appropriate for the study design?

1 Yes
2 No
3 Can't tell

(Q4) Is the analysis performed by intervention allocation status (i.e. intention to treat) rather than the actual intervention received?

1 Yes
2 No
3 Can't tell

GLOBAL RATING

COMPONENT RATINGS

Please transcribe the information from the gray boxes on pages 1-4 onto this page. See dictionary on how to rate this section.

A	**SELECTION BIAS**	**STRONG**	**MODERATE**	**WEAK**	
		1	2	3	
B	**STUDY DESIGN**	**STRONG**	**MODERATE**	**WEAK**	
		1	2	3	
C	**CONFOUNDERS**	**STRONG**	**MODERATE**	**WEAK**	
		1	2	3	
D	**BLINDING**	**STRONG**	**MODERATE**	**WEAK**	
		1	2	3	
E	**DATA COLLECTION METHOD**	**STRONG**	**MODERATE**	**WEAK**	
		1	2	3	
F	**WITHDRAWALS AND DROPOUTS**	**STRONG**	**MODERATE**	**WEAK**	
		1	2	3	Not Applicable

GLOBAL RATING FOR THIS PAPER (circle one):

1	STRONG	(no WEAK ratings)
2	MODERATE	(one WEAK rating)
3	WEAK	(two or more WEAK ratings)

With both reviewers discussing the ratings:

Is there a discrepancy between the two reviewers with respect to the component (A-F) ratings?

No Yes

If yes, indicate the reason for the discrepancy

1	Oversight
2	Differences in interpretation of criteria
3	Differences in interpretation of study

Final decision of both reviewers (circle one):

1	**STRONG**
2	**MODERATE**
3	**WEAK**

14.Appendix IV Full quality assessment results

Table 5. EPHPP full ratings breakdown

Study	Selection bias	Study design	Confounders	Blinding	Data collection Methods	Withdrawals and drops-outs	Global reading
Steinisch et al. (2011)	Q1. 3 (not likely); Q2. 1 80-100% = Weak	Q1. 8 (Can't tell) = Weak	Q1. 3 (Can't tell)/Q1. 2 (No) (?); Q2. 2 (60-79%) = Moderate	Q1. 3 (Can't tell); Q2. 3 (Can't tell) = Weak	Q1. 1 (Yes); Q2. 1 (Yes) = Strong	Q1. 4 (Not applicable); Q2. 5 (Not applicable) = Not applicable	Weak
Da Silva et al. (2018)	Q1. 3(not likely); Q2. 5 (can't tell) = Weak	Q1. 8 (Can't tell) = Weak	Q1. 2 (No); Q2. 3 (less than 60%) = Strong	Q1. 3 (Can't tell); Q2. 3 (Can't tell) = Weak	Q1. 1 (Yes); Q2. 1 (Yes) = Strong	Q1. 4 (Not applicable); Q2. 1 (80-100%) = Strong	Weak
Van Doorn et al. (2018)	Q1. 3 (not likely); Q2. 5 (can't tell) = Weak	Q1. 8 (Can't tell) = Weak	Q1. 3 (Can't tell); Q2. 4 (Can't tell) = Weak	Q1. 3 (Can't tell); Q2. 3 (Can't tell) = Weak	Q1. 1 (Yes); Q2. 1 (Yes) = Strong	Q1. 4 (Not applicable); Q2. 1 (80-100%) = Strong	Weak
Vastano et al. (2014)	Q1. 3 (not likely); Q2 .5 (can't tell) = Weak	Q1. 8 (Can't tell) = Weak	Q1. 3 (Can't tell); Q2. 4 (Can't tell) = Weak	Q1. 3 (Can't tell); Q2. 3 (Can't tell) = Weak	Q1. 1 (Yes); Q2. 1 (Yes) = Strong	Q1. 4 (Not applicable); Q2. 1 (80-100%) = Strong	Weak
García-Montes et al. (2014)	Q1. 3(not likely); Q2. 5 (can't tell) = Weak	Q1. 8 (Can't tell) = Weak	Q1. 3 (Can't tell); Q2. 4 (Can't tell) = Weak	Q1. 3 (Can't tell); Q2. 3 (Can't tell) = Weak	Q1. 1 (Yes); Q2. 1 (Yes) = Strong	Q1. 4 (Not applicable); Q2. 5 (Not applicable) = Not applicable	Weak
Rus-Calafell et al. (2013)	Q1. 3(not likely); Q2. 5 (can't tell) = Weak	Q1. 8 (Can't tell) = Weak	Q1. 3 (Can't tell); Q2. 1 (80-100%) = Strong	Q1. 3 (Can't tell); Q2. 3 (Can't tell) = Weak	Q1. 1 (Yes); Q2. 1 (Yes) = Strong	Q1. 4 (Not applicable); Q2. 1 (80-100%)= Strong	Weak
Minor et al. (2018)	Q1.3 (not likely); Q2. 5 (can't tell) = Weak	Q1. 8 (Can't tell) = Weak	Q1. 2 (No); Q2. 3 (less than 60%) = Strong	Q1. 3 (Can't tell); Q2. 3 (Can't tell) = Weak	Q1. 1 (Yes); Q2. 1 (Yes) = Strong	Q1. 4 (Not applicable); Q2. 5 (Not applicable) = Not applicable	Weak

MAIN RESEARCH PROJECT

Interpersonal sensitivity and paranoid ideation in a sample of healthy individuals with low, moderate, and high schizotypy

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King's College London

Supervised by Dr Lucia Valmaggia and Dr Elena Antonova

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ABBREVIATIONS

ABBREVIATIONS	DEFINITIONS
CAARMS	Comprehensive Assessment of At-Risk Mental States
HMD	Head mounted display
IPSM	Interpersonal Sensitivity Measure
SD	Standard Deviation
SPQ	Schizotypal Personality Questionnaire
SSPS	State Social Paranoia Scale
VAS	Visual Analogue Scale
VR	Virtual Reality

Abstract

Background: The association between schizotypy and paranoid traits has already been proved by several empirical studies, whilst others have demonstrated the link between interpersonal sensitivities with both negative prodromal psychotic symptoms and higher levels of trait paranoid ideation. No research to date has examined the relationship of schizotypy with both interpersonal sensitivity and trait paranoid ideation and whether they predict state persecutory ideation elicited by an ecologically valid Virtual Reality (VR) environment. The aim of this research was twofold: using a VR environment to investigate the association of schizotypy traits with both interpersonal sensitivity and trait paranoid ideation and to establish the test-retest reliability of the VR environment on inducing state persecutory ideation.

Method: This research encompassed two studies. Study 1 aimed to investigate the association of schizotypy with interpersonal sensitivity and trait paranoid ideation in a sample of healthy individuals (N=45), selected from a larger non-clinical population (N=181), who completed an online survey assessing schizotypy personality traits. Based on the survey scores, the sample of 45 was clustered into three groups with different schizotypy profiles: high (N=16), moderate (N=16) and low (N=13). Following the completion of measures aimed at evaluating the relationship between schizotypy, interpersonal sensitivity and trait paranoid ideation, participants undertook an immersive VR social situation task set in a pub, in which they were asked to interact with avatars. Study 2 aimed at establishing the test-retest reliability of the VR environment on inducing state persecutory ideation. All 45 participants were re-invited to complete the same VR social situation task 40 days after Study 1, to examine whether habituation or sensitisation effects occurred on measures of state persecutory ideation.

Results: Study 1 findings suggested that self-reported schizotypy was associated with interpersonal sensitivity traits (medium size effect) and trait paranoid ideation (medium size effect). Self-reported schizotypy, interpersonal sensitivity and trait paranoid ideation did not predict state persecutory ideation induced by VR. Study 2 showed that

the VR pub environment has good test-retest reliability in inducing state persecutory ideation between two assessments 40 days apart.

Conclusion: Schizotypy was associated with interpersonal and trait paranoid ideation, however interpersonal sensitivity and trait paranoid ideation did not predict state persecutory ideation induced by VR. The VR environment tested, demonstrated good test-retest reliability in assessing state persecutory ideation over time.

Keywords: Virtual Reality · Schizotypy · Psychosis proneness · Psychosis prone personality · Interpersonal Sensitivity · Paranoid ideation

1. Introduction

1.1. Schizotypy and schizophrenia

Rado (1953) and Meehl (1962, 1989) were the first to introduce the concept of schizotypy as the phenotypic expression of latent genetic vulnerabilities for the schizophrenia-spectrum. Meehl (1962, 1989) elaborated the "quasi-dimensional" model suggesting schizotypy features to only belong to clinical and sub-clinical populations, whose symptomatology moved on a continuum between personality psychopathology and full-blown schizophrenia. This view of schizotypy's dimensionality, which focused only on variations within the illness domain, was later substituted with a full-dimensional approach which included normality and/or health dimensions (Raine et al. 1995; Claridge 1995).

Thus, Claridge's (1995) "fully dimensional approach" of schizotypy suggested the presence of a continuum of schizotypy traits that extended beyond clinical and sub-clinical groups, including the general healthy population, and provided an explanation of the presence of nonclinical variations of psychotic-like traits in healthy groups. This was in line with studies describing the presence of sub-clinical expressions of psychosis amongst healthy adults with high schizotypal traits (Kwapil et al. 2008).

1.2. Schizotypy and its multidimensionality

Schizotypy is composed of three dimensions: positive, negative and disorganised, with the first two being the most traditionally stated (Raine 1991). Each schizotypy domain is uniquely related to specific personality, psychopathology and functioning deficits. The positive dimension (or cognitive-perceptual) characterised by hallucinations, disturbances in thought content (including magical thinking and clinical delusions), suspiciousness and paranoid ideation has been associated with mania, hypomania moods and dysregulation in affect; whereas the negative dimension, (or interpersonal) which comprises blunted affect, anhedonia, alogia, anergia and avolition with personality organisation characterised by introversion, social isolation and low openness Kwapil et al. (2008, 2012). The disorganised dimension includes difficulties

with organising and expressing speech and behaviours of which severity can range from mild disruptions to acute disorganised actions (Fonseca-Pedrero et al. 2011; Reynolds et al. 2000). The 74-item Schizotypal Personality Questionnaire (SPQ), elaborated by Raine (1991), is the associated self-report measure for the assessment of schizotypal personality disorder in the general population.

Several studies have reported both positive and negative schizotypy to be predictors of the development of schizophrenia-spectrum disorders and impairments in social functioning, with the positive schizotypy scores being associated with psychotic-like psychopathology and negative scores with schizoid symptoms (Kwapil et al. 2008). In particular, the ideas of reference and no close friends subscales of the SPQ have been identified as strong predictors for transition to psychosis (Salokangas et al. 2013).

Overall, the multidimensionality element of schizotypy has offered a new insight into the aetiology, developmental trajectories, risk factors and expression of schizophrenia spectrum disorders (Ettinger et al. 2014), providing clinicians and researchers with valuable evidence to formulate potential preventative interventions.

1.3. Schizotypy and paranoid ideation

The multidimensionality that characterises schizotypy extends to its domains. Evidence suggests that the positive schizotypy domain is composed of multiple factors (Raine 1991). Its three-factorial structure is composed of: cognitive-perceptual aberrations, referential thinking and paranoia.

The presence of psychotic phenotypes amongst general populations is well-recognised (van Os et al. 2000; Nuevo et al. 2012). Evidence gathered from studies investigating psychotic-like symptoms in non-clinical groups have reported that between 10%-30% of individuals experience persecutory thoughts (Freeman et al. 2005) and 40% experience paranoid ideation (Freeman et al. 2008a).

Environmental stressors and adverse life experiences have been deemed to have a determining role in the formation and maintenance of reasoning biases which have been

demonstrated to have a key role in the attribution of specific and sometimes distressing, significances to neutral virtual stimuli (Freeman et al. 2003).

Maladaptive cognitive appraisals have been identified as the differentiating factor between individuals with a clinical diagnosis of psychosis and healthy individuals who persistently experience psychotic symptoms but do not need care, suggesting that the severity of distress caused by anomalous experiences is linked to how threatening the experiences themselves have been appraised (Peters et al. 2017).

Freeman's et al. (2005) *hierarchy of paranoia* model provided a new understanding of the presence of paranoid ideation in the general population and explanation of the relationship between attribution of significance and threat-based appraisals. His model suggested that the intensity of distress associated with a paranoid thought depended on how common the content of the thought was: common preoccupations, such as "social evaluative concerns" were generally perceived as less distressing than rarer and less endorsed ideas, like "severe threat of being harmed by others".

Unusual thought content and persistent ideas of reference, alongside other biopsychosocial risk factors, have been identified as significant risk factors predicting psychosis conversion (Cannon et al. 2008). In particular, poverty of thought content and paranoid thinking (Wilcox et al. 2014) have been found to be more severe in those who were at risk of psychosis and converted into clinical presentation than those who were still at risk but did not transition (Perkins et al. 2015).

Providing further evidence regarding the risk factors for conversion to psychosis and schizophrenia, Barrantes-Vidal et al. (2013) demonstrated positive schizotypy to be associated with a wide range of schizophrenia prodromal symptoms, such as positive, negative, cognitive and behavioural, as well as emotional disturbance and general psychopathology as measured by the CAARMS (Comprehensive Assessment of At-Risk Mental States). The results of this study offered some clarification regarding the long-term trajectory of the positive dimension and its contribution to the expression of attenuated prodromal psychotic symptoms, which Keith and Matthews (1991)

described as a “heterogenous group of behaviours temporally related to the onset of psychosis”.

1.4. Schizotypy and interpersonal sensitivity

With a substantial volume of empirical evidence describing symptoms related to positive schizotypy as one of the most common features of the prodromal phase of psychosis (Miller et al. 1999; Broome et al. 2005; Yung et al. 2005), the need to identify and address psychotic vulnerability factors has gained considerable interest in research (Nelson et al. 2013; Raballo & Larøi 2011).

Studies investigating traits associated to positive schizotypy, such as paranoid and persecutory ideation in healthy populations, have found them to correlate with preoccupations related to the social aspect of self, heightened self-awareness, low self-esteem (Martin et al. 2001) and interpersonal sensitivity (Freeman et al. 2005, Green et al. 2008). These findings encouraged empirical analyses to start placing particular emphasis on the interpersonal sensitivity construct and its role as a risk factor for psychosis.

Boyce and Parker (1989) described interpersonal sensitivity as “undue and excessive awareness of and sensitivity to, the behaviour and feelings of others” (p. 342). The Interpersonal Sensitivity Measure (IPSM) (Boyce & Parker 1989) is a self-report scale composed of 36 items created to measure the above concept. It includes five domains: interpersonal awareness, need for approval, separation anxiety, timidity and fragile inner-self.

Interpersonal sensitivity has been associated with the prodromal phase of psychosis (Masillo et al. 2012) and described as a predictor of social anxiety and state paranoia (Freeman et al. 2008a, 2008b), with some of its subscales, such as fragile inner-self to be particularly correlated with paranoid ideation (Valmaggia et al. 2007).

Mirroring these findings, a recent systematic review focusing on exploring the internal processes of paranoia, highlighted the strong association between interpersonal

sensitivity and paranoia across both clinical and non-clinical populations (Meisel et al. 2018). This strengthened the hypothesis of personal vulnerabilities and heightened preoccupations related to social evaluations, having a central role in the onset and maintenance of unfounded fears that others intend to cause you harm, which characterised paranoid thinking (Freeman et al. 2007).

Interpersonal sensitivity has also been described as a vulnerability factor for the development of depression (Boyce et al. 1996) with recent studies highlighting the robust link between its five components and negative core-beliefs of self (Otani et al. 2018). The latter contributes to cognitive vulnerabilities and maladaptive appraisals, which hold a key role in the determination of the level of distress associated with anomalous experiences (Mehl et al. 2014), which literature describes as being part of the positive schizotypy domain (Kwapil et al. 2008).

Expanding on these findings, researchers have described negative views of self, in the context of early life trauma, to be a predictor of elevated rates of paranoia (Fisher et al. 2012). Similarly, McDonnell et al. (2018) discussed the mediation role of interpersonal sensitivity in indicating trait paranoid ideation in a population of people at clinical risk for psychosis. The study noted the unidirectional trajectory of adverse experiences, such as bullying, in predicting interpersonal sensitivity, which in turn, predicted state of paranoia. Triggering events or anomalous experiences have been also described as a contributing factor to the disruptions in cognitive processes which have demonstrated to have a mediating role between paranormal experiences and schizotypy (Mathijsen 2015).

Additional meta-analyses have identified stressful episodes, such as childhood trauma and adverse life events, as key features to the development of a fragile inner-self (a sub-construct of interpersonal sensitivity), which has been considered by some authors as the first step of the transition to psychosis in ultra-high-risk individuals (Fusar-Poli et al. 2017; Valmaggia et al. 2016a). Further studies have indicated that interpersonal sensitivity relates to rejection sensitivity (Premkumar et al. 2018) and to attenuated

positive psychotic symptoms during the prodromal phase of psychosis and at 18-month follow-up periods (Masillo et al. 2012, 2016).

In light of the empirical evidence illustrated so far, it is possible to conclude that the interpersonal sensitivity construct is strongly correlated with state of paranoia.

1.5. *The use of VR to investigate paranoid ideation*

Over the last two decades the use of technology within research and clinical practices has significantly increased (David et al. 2013), resulting in novel scientific approaches, such as VR, progressively becoming an important part of the assessment, understanding and treatment of mental health problems (Freeman et al. 2017; Valmaggia et al 2016b).

VR is a multi-sensory interactive computer-generated world that allows subjects to experience the sensation of actually being in a real-life sized environment by replacing the real-world sensory perceptions with digitally created ones (Freeman et al. 2017). This is enabled through using a series of technological devices, such as a head mounted display (HMD). The 'sense of presence' in an interactive 3-dimensional virtual world provides users with the illusions of 'being fully there' and 'believing that the depicted scenario is actually occurring'. Slater (2009) describes these processes as place illusion and plausibility illusion, both core elements for the creation of a realistic and relatable virtual environment that facilitates new learning responses.

Immersive VR has been demonstrated to be suitable to assess state paranoia (Valmaggia et al 2016a) and to reduce paranoid ideation and situation-specific anxiety in patients with a diagnosis of psychosis (Pot-Kolder et al. 2017). Furthermore, VR has been defined to be equipotent to in vivo exposure therapy as it supports individuals to confront the feared stimuli, and through the process of habituation, decreases anxiety with prolonged and repeated therapeutic 'virtual' exposures (Gerardi et al. 2010). VR environments have also been proven to be an effective intervention in reducing avoidance and facilitating emotional processing, as well as encouraging individuals to think, react and behave differently when in specific situations (Powers et al. 2008).

The use of VR has been applied across different areas of mental health, from the assessment of symptoms to the development of treatment (Freeman et al. 2008a) and its effectiveness has been widely demonstrated across a diverse range of mental health disorders (Valmaggia et al. 2016b). Furthermore, virtual environments are ecologically valid as they depict real-life events through the use of plausibility illusion (Freeman et al. 2017).

VR has the potential to objectively assess cognitive, behavioural and physiological components of social performance in a controlled environment (Riches et al. 2019) and to allow clinicians to conduct ecologically valid exposure work (Rus-Calafell et al. 2017). However, to date, no study has investigated its test-retest reliability in assessing specific constructs over time or explored its potential use as an objective assessor of treatment outcomes and effectiveness.

2. Aims of the research

This research is composed of two studies: *Study 1* (refer to Figure 1(b) page 84) aimed at investigating the association of schizotypy traits with both interpersonal sensitivity and trait paranoid ideation and explored whether an immersive VR social situation, in which participants were asked to interact with avatars, induced state persecutory ideation; *Study 2* (refer to Figure 1(c) page 84) aimed at establishing the test-retest reliability of a VR pub paradigm in inducing state persecutory ideation.

STUDY 1. Examining the association of schizotypy with interpersonal sensitivity and trait paranoid ideation.

3. Introduction

The aim of *Study 1* was to investigate the association of schizotypy traits (low, moderate and high) with interpersonal sensitivity and trait paranoid ideation and whether these three constructs predicted state persecutory ideation induced by VR.

3.1. Research questions

Question 1: Are higher schizotypy traits associated with higher interpersonal sensitivity scores and trait paranoid ideation?
Question 2: Does exposure to the VR environment elicit state persecutory ideation?
Question 3: Do higher baseline schizotypy traits predict higher state persecutory ideation as induced by the VR environment?
Question 4: Do higher interpersonal sensitivity traits predict higher state persecutory ideation as induced by the VR environment?

3.2. Hypotheses

Study 1:
Hypothesis 1: Higher levels of schizotypy will be associated with higher interpersonal sensitivity and higher levels of trait paranoid ideation.
Hypothesis 2: Exposure to the VR environment will elicit state persecutory ideation.
Hypothesis 3: Higher levels of schizotypy will predict increased state persecutory ideation in VR.
Hypothesis 4: Higher levels of interpersonal sensitivity will predict increased state persecutory ideation in VR.

4. Method

4.1. Design

Cross-sectional cohort study.

4.2. Procedure

A total of 181 participants completed the online survey which included the Schizotypal Personality Questionnaire (SPQ) (Raine, 1991). To avoid using the word ‘schizotypy’, which could be perceived as stigmatising, the survey was advertised as aiming to

improve the understanding of the link between personality traits and people's thoughts and feelings about social situations. The survey could be completed on any digital device connected to the internet and took approximately 10-15 minutes.

Based on the SPQ scores, the 181 individuals were clustered into three groups, each with a different schizotypy profile: high (>+0.5 S.D.), moderate (between -0.5 S.D. and + 0.5 S.D.) and low (<-0.5 S.D.). A total of 45 participants were selected (16 from the high group, 16 from the moderate and 13 from the low) for *Study 1* and invited to take part in the first laboratory-based appointment during which self-report measures of interpersonal sensitivity, paranoia and mood were administered and a VR pub task was undertaken. The figure below illustrates the steps taken to carry out the study.

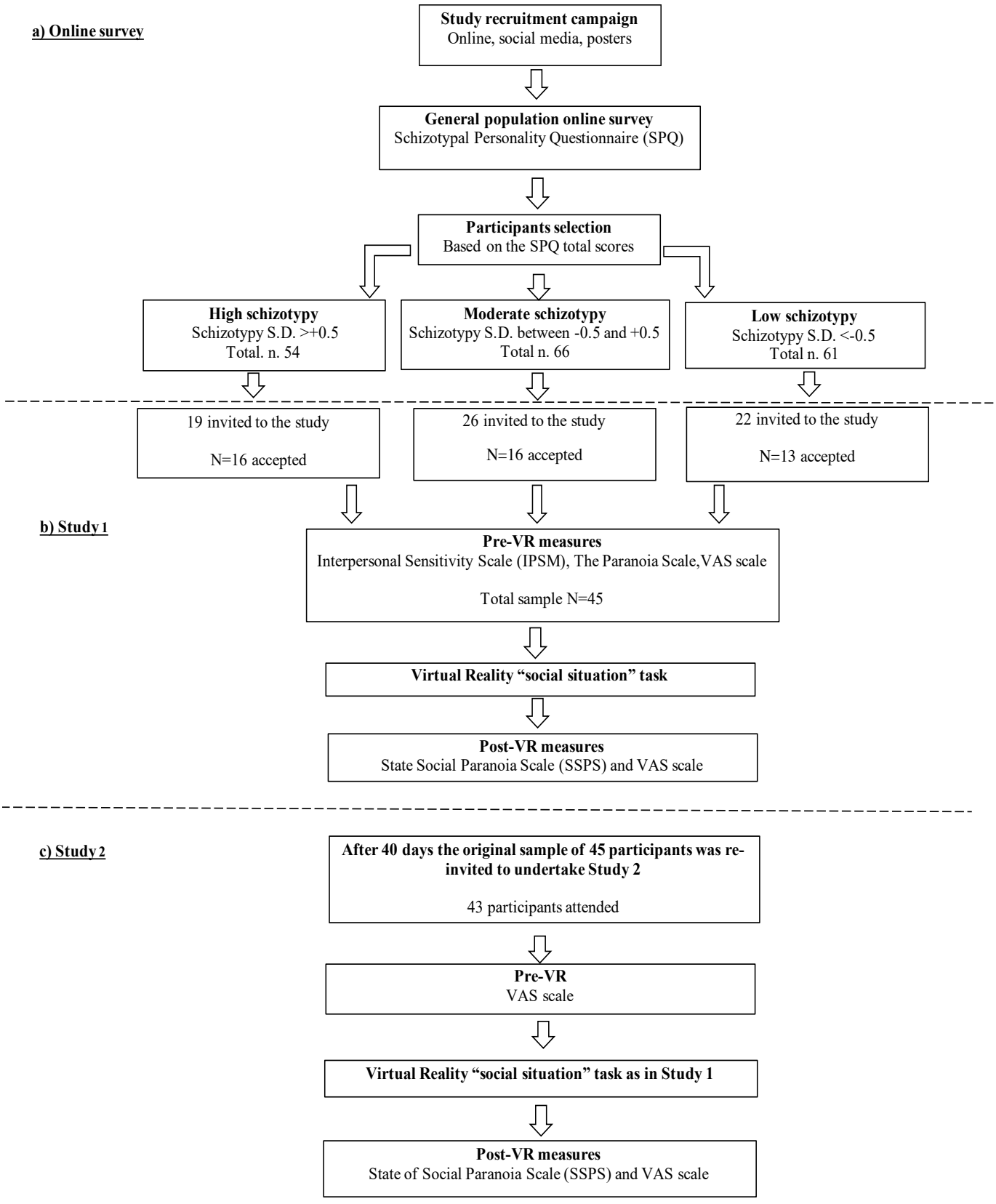

Figure 1. a) online survey, b) Study 1, c) Study 2

5. Online survey

5.1. Participants

Participants were recruited form the general population aged between 18 and 65 years with no history or current diagnosis of a serious mental health illness (e.g., psychosis or bipolar disorder), a neurological disorder, a learning disability or substance abuse. They were fluent in English, had no hearing impairments and did not suffer from photosensitive epilepsy.

5.2. Participant recruitment

A series of different platforms were used to advertise the study and to recruit participants. The study was publicised on Twitter (www.twitter.com), Facebook (www.facebook.com) and on The East Dulwich Forum (www.eastdulwichforum.co.uk). Other London based Doctorate programmes in Clinical Psychology disseminated the study amongst their trainee clinical psychologists. The study adverts on social media were often shared and re-tweeted by other users. Recruitment was also advertised through the fortnightly King's College London bulletin circular email. Flyers and posters of the study were disseminated across three King's College campuses (Denmark Hill, Guy's and the Strand) and in the London Boroughs of Southwark and City of Westminster. Furthermore, colleagues, family and friends also assisted in the dissemination of the study online survey through their social accounts. See Appendix II for recruitment tools.

6. Measures

6.1. Online survey constructions

The electronic platform *Online survey* (https://www.onlinesurveys.ac.uk/), formerly known as BOS, was utilised to develop the online survey. The settings activated did not

allow participants to skip or provide multiple answers. See Appendix III for Online Survey output.

6.2. Online survey demographic items and self-report measure

Demographics. The demographics collected for this study included: age, gender, employment status, marital/relationship status, current living arrangements, highest academic achievement and ethnicity.

Schizotypal Personality Questionnaire (SPQ). The Schizotypal Personality Questionnaire (Raine 1991) was used to assess positive, negative, and disorganized schizotypy dimensions. The SPQ consists of 74 items comprising the nine subscales that reflect nine features of schizotypy as defined by DSM-III-R: Ideas of Reference (9 items, range 0-9); Excessive Social Anxiety (8 items, range 0-8); Odd Beliefs/Magical Thinking (7 items, range 0-7); Unusual Perceptual Experiences (9 items, range 0-9); Odd or Eccentric Behaviour (7 items, range 0-7); No Close Friends (9 items, range 0-9); Odd Speech (9 items, range 0-9); Constricted Affect (8 items, range 0-8) and Suspiciousness (8 items, range 0-8). Higher total scores for the whole measure indicate heightened schizotypy personality traits. The minimum total score is 0 and the maximum 74. No items are reversed scored. The questionnaire requires participants to answer statements with either yes or no. 'Yes answers' have the value of 1 and 'No answers' of 0. The questionnaire has demonstrated to have high internal reliability, sample validity and test-retest reliability (Raine 1991). Sample items include 'Do you sometimes feel that things you see on TV or read in the newspaper have a special meaning to you?' and 'I sometimes avoid going to places where there will be many people because I get anxious'.

Participants were asked to read the following statement before completing the survey: 'The statements below inquire about your personal beliefs regarding a variety of situations. Consider each statement carefully. Then indicate whether the statement is true or false with regard to your typical behaviour.' See Appendix III for Online Survey output.

6.3. Informed consent

The online survey included an information sheet and consent form. Participants had to write the sentence 'I consent' in a specific window in order to agree with the study's criteria and for their data to be considered. Participants were reminded that participation was completely voluntary and they could take as much time as they needed to decide whether they wanted to take part in the study. See Appendix III.

6.4. Participation incentives

On completion of the online survey, participants were entered into a draw to win one of four Amazon vouchers worth £25 each. They were also informed that depending on their responses, they may be invited to take part in the following stage of the study, which included two appointments during which they would complete a VR task.

6.5. Potential risk

Before completing the online survey and prior to participant selection for *Study 1*, participants were informed of the possible risks associated with undertaking the VR task. They were made aware that feeling nauseous and/or experiencing disturbances in vision whilst and after using head-mounted displays were possible side effects. They were also informed that they could stop taking part in the study at any point due to feeling unwell or because of any other reason. Participants were also advised, not to drive a car, motorcycle, or use any piece of complicated machinery in the four hours immediately following being in virtual reality. Possible side effects of using virtual reality equipment, such as "flashbacks" were also discussed and therefore those with a history of epilepsy were encouraged not to take part in the study. See Appendix III.

6.6. Participant confidentiality

Participants were made aware that all the responses given were processed in accordance with the General Data Protection Regulation 2016 (GDPR) and were confidential.

Participants' email addresses were collected in the eventuality of researchers needing to contact them for the virtual reality study or for letting them know that they had won one of the Amazon vouchers. Participants were given the option to provide their names and phone numbers. No identifying information, such IP addresses or home addresses were collected. All research data stored electronically was encrypted. All the data were downloaded to a secure file, and participants' contact detail(s) were kept separate from the survey data. Participants were identified by a participant number which started from 0001. Numbers were allocated chronologically from the date of completion of the online survey. Participants were made aware that the results of the study were used for academic publications and presentations, but all data were anonymised.

6.7. Freedom to withdraw

Before they began the survey, participants were asked to complete a brief consent form to ensure that they were eligible and understood what was involved in the study. Participants were free to withdraw at any point of the study, without having to give a reason. They were explained that withdrawing from the study did not affect them in any way. Partially completed questionnaires were not used. After taking part in the online survey, participants were entitled to withdraw their data up until the time the results of the study were analysed and written up (31st March 2020). Those who were invited for the virtual reality study, were free to decline the invitation.

6.8. Participation benefits

As well as being compensated for their time, participants were explained that their involvement in this research would have contributed towards the future development of an innovative and effective assessment and treatment approach to help people with serious mental health problems facing difficulties with social situations.

6.9. Projected sample size

To our knowledge there are no studies investigating the presence of a correlation between schizotypy (as measured by SPQ – Raine 1991), interpersonal sensitivity (as measured by IPSM - Boyce et al. 1989) and trait paranoid ideation (as measured by the Paranoia Scale - Fenigstein and Vanable 1992) and whether these three constructs predict state persecutory ideation (as measured by the persecutory ideation^{SSPS} subscale - Freeman et al. 2007). Therefore an a priori power calculation was conducted based on a previous study investigating similar constructs: the correlation between schizotypy and interpersonal sensitivity (Green et al. 1999). A priori power analysis indicated that with a sample size of 40 individuals and an α error probability of 0.03 there was a 0.80 power of detecting a medium size effect.

6.10. Research approvals

The pilot study received ethical approval from the Psychiatry, Nursing and Midwifery Research Ethics Subcommittees (PNM RESC) on 10th July 2019 (HR-18/19-11624). King's Data Protection Registration (KDPR) was granted on 30th July 2019. See Appendix I for Research Ethics Committee documents.

6.11. Statistical analysis strategy

All statistical analyses were carried out using SPSS Version 25 (SPSS Inc., Chicago, USA; www.spss.com). At this stage only reliability analyses were carried out in order to assess the internal consistency of the SPQ scale.

7. Results

7.1. Sample characteristics

The online survey was completed by 181 individuals. Table 1 illustrates the demographic characteristic of the entire sample.

Table 1. Demographic characteristic of online survey sample

Demographic	**Total sample N=181**	
Age (years)	Mean (SD, range)	
	27.68 (8.93 – 18-64)	
Gender		
Females	130	71.82%
Males	51	28.18%
Ethnicity		
White	113	62.43%
Asian/ Asian British	31	17.13%
Mixed/Multiple ethnic groups	16	8.84%
Other ethnic group	15	8.29%
Black/ African/ Caribbean/ Black British	6	3.31%
Level of education		
Undergraduate degree	72	39.78%
AS, A-levels, (G)NVQ	46	25.41%
Masters degree	42	23.20%
Doctorate, PhD	17	9.40%
O-Levels, GCSEs, GCEs	3	1.66%
No formal qualifications	1	0.55%
Employment Status		
Student	89	49.17%
Full-time paid employment	65	35.92%
Part-time paid employment	13	7.18%
Unemployed	9	4.97%
Other	5	2.76%
Relationship/marital status		
Single	78	43.10%
Cohabiting	40	22.10%
In a relationship	33	18.23%
Married	24	13.26%
Other	3	1.66%
Separated	2	1.10%
Divorced	1	0.55%

Living arrangements		
I am renting a house/flat	66	36.47%
I am renting a room in house share	49	27.07%
I live with my parents	26	14.36%
I own the house/flat where I am living	24	13.26%
Other	10	5.52%
I am renting a bed-sit	5	2.77%
I am staying in a hostel	1	0.55%

7.2. Recruitment sources

65.56% of participants became aware of the online survey through internet-based platforms. Only one participant did not provide information about the source that made them aware of the study. Table 2 provides an overview of the way participants found out about the study.

Table 2. Participant recruitment sources

Way of finding out about study	N=180 (%)
Email	76 (42.22)
Facebook	10 (5.56)
Messaging/chat service (e.g. SMS, WhatsApp)	2 (1.11)
Online advert	10 (5.56)
Online forum	2 (1.11)
Other	6 (3.33)
Poster/Flyer	50 (27.78)
Twitter	9 (5)
Verbally informed	4 (2.22)
Website	11 (6.11)

7.3. Reliability analysis

In the current study, the Cronbach alpha coefficient for the SPQ scale was .947. All SPQ subscales reported adequate internal consistency. The Cronbach alpha coefficients for each SPQ subscales are outlined in Table 3.

Table 3. SPQ scale reliability (sample N=181)

Scale	Total sample N=181
SPQ tot	0.947
SPQ subscales	
Ideas of reference	0.807
Excessive Social Anxiety	0.805
Odd Beliefs or Magical Thinking	0.789
Unusual Perceptual Experiences	0.758
Odd or Eccentric Behaviour	0.812
No Close Friends	0.778
Odd Speech	0.788
Constricted Affect	0.771
Suspiciousness	0.762

SPQ, Schizotypal Personality Questionnaire.

7.4. Schizotypy measurement

The sample's measures regarding the SPQ and its related subscales are shown in Table 4.

Table 4. Sample's (N=181) schizotypy scores

Scale	Total sample N=181
	Mean (SD, range)
SPQ tot	21.2 (14.46, 0-61)
SPQ subscales	
Ideas of reference	2.58 (2.53, 0-9)
Excessive Social Anxiety	3.71 (2.48, 0-8)
Odd Beliefs or Magical Thinking	1.23 (1.76, 0-7)
Unusual Perceptual Experiences	1.89 (2.07, 0-8)
Odd or Eccentric Behaviour	1.82 (2.05, 0-7)
No Close Friends	2.50 (2.36, 0-9)
Odd Speech	3.28 (2.53, 0-9)
Constricted Affect	1.88 (2.00, 0-8)
Suspiciousness	2.30(2.15, 0-8)

SPQ, Schizotypal Personality Questionnaire.

7.5. Summary of main findings of online survey

The sample of participants (N=181) was mainly composed by young individuals with a mean age of 27.68 (SD 8.93), ranging from 18 to 64. 71.82% of participants were female with a mean age of 26.74 (SD 8.64). 62.43% were white. 49.17% were students and 35.92% were in full-time paid employment. 43.10% were single and 53.58% were either in a relationship, cohabiting or married. The SPQ demonstrated good internal consistency.

8. Discussion

The aim of the online survey was to identify a pool of people from the general population in order to establish schizotypy level. The sample (N=181) was divided into three groups on the basis of their SPQ total scores: low schizotypy (<-0.5 S.D.), moderate schizotypy (between -0.5 S.D. and + 0.5 S.D.) and high schizotypy (>+0.5 S.D.) from which participants for *Study 1* were then selected.

The average SPQ questionnaire score in our sample was 21.2 ± 14.46, similar to the scores found in other studies investigating schizotypy in student populations (van Rijn et al. 2015; Hall et al. 1996). These figures allowed researchers to tentatively conclude that the sample (N=181) schizotypy scores were representative of the schizotypy characteristics reported in the general population.

8.1. Limitations

The recruitment strategy used has some limitations. A methodological limitation was the self-report nature of the study design, making it difficult to ensure that the responses given by participants were truthful. Surveys and self-reports are inherently biased by social desirability and the person's feelings at the time of the completion of the questionnaire. Participants may also have found some of the content of the questions sensitive or too technical and ambiguous to understand and therefore replied in a way

that was socially acceptable. These factors may have skewed the internal validity of the scale.

Furthermore, the platforms used to publicise the study only reached out to populations with specific characteristics, such as being students, highly educated, technology-friendly, social-media and internet users and living or working in affluent areas across the London Boroughs of Southwark or City of Westminster. This may have resulted in recruiting a sample with characteristics that differ from the general population. The predominance of women in the sample is in line with other studies reporting that usually more women than men take part in online psychological studies (Birnbaum 2001). As highlighted in both Riches et al. (2019) and Freeman's et al. (2005) analyses, participants who self-select for these types of studies may be more prone to psychological disturbances and this, combined with the stigma of appearing to have psychological difficulties, might skew the representativeness of the sample. It is unclear whether participants followed the exclusion criteria regarding their mental well-being when signing up to take part in the study, therefore it is unknown if some participants had a history or current diagnosis of a mental health disorder or whether they were under the influence of substance. In light of these limitations, it is important to be cautious when drawing epidemiologic conclusions from the study's findings.

9. Virtual Reality Study

9.1. Participants

As described in the previous section, participants were recruited from those who took part in the online survey based on their SPQ scores. They were working age adults (aged 18-65), fluent English speakers, with no history or current diagnosis of a serious mental health illness (e.g., psychosis or bipolar disorder), a neurological disorder, a learning disability or substance abuse. They had no hearing impairments and did not suffer from photosensitive epilepsy. The SPQ total scores and related S.D. were calculated for each of the 181 individuals and organised in ascending order. The scores of those who fell above +0.5 S.D. were classified as high schizotypy (N=54), below -

0.5 S.D. were categorised as low schizotypy (N=61) and between -0.5 and +0.5 S.D. as moderate schizotypy (N=66). Each participant was assigned a participant number. Once the high, moderate and low schizotypy groups were identified (based on their SPQ score), the participant number lists for each group were randomised to reduce the likelihood of introducing unmeasured confounding variables. Three random samples of 15 participants were taken from each group, merged together and then randomised before being invited for the VR task. Only after this point, the identity and contact details of each participant were revealed to the researcher. This ensured that all researchers were blinded to the participants' group (i.e. high, moderate, or low schizotypy) status.

A reserve list for each group was kept to draw further participants if those who had been invited were unable or unwilling to participate. Participants from the reserve lists were invited in batches, which allowed researchers to apply the same randomisation and blinding procedures to those invited from the reserve lists as to the original list of invited participants. During the VR task, participants were blind to their group status. Recruitment stopped when a total of 45 participants agreed to participate.

9.2. Participant recruitment

Participants were contacted by email to invite them to take part in the VR study at the Institute of Psychiatry, Psychology & Neuroscience (IoPPN). They were informed that they could attend any available appointments at their convenience. The appointments were scheduled with Doddle (https://doodle.com/en/) and they were available on weekdays from 6 p.m. until 9 p.m. and at weekends from 10 a.m. until 5 p.m.. Participants could book an appointment by accessing Doodle online. Participants had two weeks to decide whether they wanted to take part in the study or not. See Appendix IV for *Study 1* invitation email.

9.3. Informed consent

Information sheet and consent forms for *Study 1* were emailed to participants. Hard copies were also made available at the first appointment. Consent forms were signed by participants in the presence of a researcher. See Appendix V.

9.4. Participant confidentiality

Participants were made aware that all the personal data collected were anonymised by replacing it with a unique 4-digit numerical identification number, which they used to book appointments on Doodle. They were informed that any data received from them were stored in a password protected electronic format. Participants were aware that confidentiality could have been broken in the event of them disclosing information that suggested their own health or safety, or that of someone else was in danger. Participants' consent forms and confirmation of participation documents for both studies were stored in a locked cabinet located in a locked room at the IoPPN. See Appendix V.

9.5. Participation incentives

Participants who were invited and attended the VR task were given £10 cash for each attended appointment, for a maximum of £20.

9.6. Potential risks

Participants were informed of potential risk of experiencing some degree of nausea. The information sheet stated that they could stop taking part in the study due to this or any other reason at any time. It also advised not to drive a car, motorcycle, or use any piece of complicated machinery in the four hours immediately following being in virtual reality. See Appendix V.

9.7. Freedom to withdraw

Participants were free to withdraw from the study at any time, without needing to provide a reason. The data of those who decided to withdraw were immediately removed from the study. If participants no longer wished for their data to be included in the publication of this study, they were free to withdraw them, up until the time the results of the study were analysed and written up (31st March 2020).

9.8. Instruction for VR data collection

A modified version of the instruction manual for data collection elaborated by Riches et al. (2019) was used to ensure that the researchers involved in the study used a consistent methodology for data collection. See Appendix VI.

9.9. VR environment

The VR 'pub' environment, created by Dr Lucia Valmaggia, has been used previously (Riches et al. 2019). It presents a virtual social situation in which participants experience a number of ambiguous social situations involving interaction with avatars. Participants were presented with the 3D images through a head-mounted display (HMD). As in Riches et al. (2019) and Valmaggia's et al. (2015) studies, participants were given the following instruction before commencing the task: 'While you are in the pub please try to get an impression of what the people in the pub think about you and what you think about them. If someone asks you a question, try to reply to them'.

The VR task commenced with the participant being on a street. They were told to use the joystick to move forward so that they could follow fluorescent green circles that defined the path that they had to take. Participants were directed to enter a pub and to explore it by following the fluorescent green marks. When in the virtual reality pub, participants were greeted by an avatar and experienced a range of negative, positive and neutral interactions. The avatar represented people of different ethnicities (White, Asian, Black) and their ages ranged from 20 to 30 years old. The VR pub experience

began and ended with interactions that required answering questions by speaking out loud to the avatars. In the first interaction, participants were asked to introduce themselves, whereas in the last conversation they were asked what their favourite TV programme was and to describe it. Throughout the pub visit, there were background noises of different content, some were positive ('she is so nice'), some negative ('what a loser!') and some were neutral interpretations ('what a joke!"). The length of the VR pub environment tasks was approximately 5 minutes. See Appendix XI for VR environment stills.

9.10. VR apparatus

The VR equipment used in this study was similar to the one utilised in Riches' et al. (2019) research.

Head-mounted display. An Oculus Rift VR headset or head-mounted display (HMD) was used to provide participants with a fully immersive, 3D visual experience. This also incorporated headphones that covered participants' ears.

Software. The VR environment was commissioned by King's College London, and designed by software company Virtualware, using the Unity VR platform.

Control pad. A computer console control pad with inbuilt joystick was used by participants to move forward and backwards in the VR. Fluid, 360-degree movement was obtained by participants turning their body direction whilst manipulating the control pad.

Desktop computer. An Alienware PC was used by the researcher to run and control the VR scenario.

Tablets. All measures were completed by participants on 7" tablets provided by researchers. Two tablets were used.

9.11. Pre-VR self-report measures

Interpersonal Sensitivity Measure (IPSM). The IPSM (Boyce & Parker 1989) is composed of 36 self-statements which are rated on a four-point scale with 1 indicating 'very unlike self' and 4 "very like self'. The total score of the scale ranges from 36 to 144. IPSM is composed of five sub-scales: 'interpersonal awareness' (7 items, range 1–28); 'need for approval' (8 items, range 8–32); 'separation anxiety' (8 items, range 8–32); 'timidity' (8 items, range 8–32) and 'fragile inner-self' (5 items, range 5–20). Higher scores indicate greater interpersonal sensitivity. The IPSM has good psychometric properties. A sample item is 'I feel insecure when I say goodbye to people.'

The Paranoia Scale. The Paranoia Scale (Fenigstein and Vanable 1992) is a self-report questionnaire composed of 20-items. It assesses frequency of sub clinical levels of trait paranoia. It is scored on a 1–5 likert scale with scores ranging from 20–100. Higher scores reflect higher levels of sub clinical paranoia. The scale has demonstrated good internal consistency and stability. A sample item is "I sometimes feel as if I'm being followed'.

Participants also completed the *Stress, Anxiety, Sadness, and Happiness Visual Analogue Scales (VAS)* but this was not included in the present study.

9.12. Post-VR self-report measures

State Social Paranoia Scale (SSPS). SSPS measures state paranoid ideation about a social situation (Freeman et al. 2007). It is composed of 20-items measured on a 5-point scale, from 1 ('Do not agree') to 5 (Totally agree). Higher scores on the persecutory ideation scale indicate greater level of persecutory thinking. The scale assesses persecutory ideation (10 items, range 10-50), neutral ideation (5 items, range 5-25) and positive ideation (5 items, range 5-25) about the avatars. It demonstrated good psychometric properties. Sample items include 'Someone was hostile towards me' and

‘No-one had any particular feelings about me’. This study only focused on state persecutory ideation. Therefore, the statistical analyses only included the scores obtained from the persecutory ideation^{SSPS} subscale.

Visual Analogue Scales (VAS) to measure components of social performance and mood. The VAS consisted of 15 items on a 10-point scale, from 1 (‘Not at all’) to 10 (‘Extremely’). Participants were given the following instructions: ‘For the following questions, please rate how you feel “right now” from 1 ("not at all") to 10 ("extremely")’. A sample item is ‘How much did you enjoy the VR experience?’. Only the results from the VAS scales examining the sense of presence and enjoyment experienced by participants during VR were included in this study.

Participants also completed a short audiotaped semi-structured interview designed for measuring persecutory ideation in VR environments (Freeman et al. 2003). The modified version created by Riches et al. (2009) was used for this study. See Appendix XII. The information gathered from the audio-recordings was not included in this study.

9.13. Researchers

Two assistant psychologists assisted with the recruitment of participants. Six sessions were held, prior to the beginning of data collection, in which all researchers took part in role plays. This aimed to support researchers to familiarise themselves with the laboratory equipment and recruitment procedures so that consistency between practices was enhanced.

9.14. Online surveys

Two different online surveys (Online surveys formerly BOS) were created for Study 1: one for pre- and one for post-VR self-report measures. See Appendixes VII and VIII.

9.15. Participant briefing

Participants were briefed before and debriefed after undertaking the VR reality tasks. Before commencing the experiment, they were asked whether they were able to attend both VR appointments with the second one being approximately 40 days after the first

one. They were also reminded of the three stages of the task: pre-VR questionnaires, VR-task and post-VR questionnaire. All participants were re-explained the possible side effects associated with the use of HMD, such as cybersickness and that they could stop taking part to the study at any time. They were told that the study was investigating the association between personality traits and social paranoid ideation and that people with different personality traits had been invited to the study. Participants were also informed that the researchers did not know about their personality traits. Information leaflets that normalised paranoia in the general population were available and given if required (see Appendix XIII). Participants were signposted to GP and/or A&E if reported to be in distress.

9.16. Statistical analysis strategy

All statistical analyses were carried out through SPSS Version 25 (SPSS Inc., Chicago, USA; www.spss.com). Nonparametric tests were used for non-normally distributed data, with Spearman rho for investigating the correlations between the variables, and Kruskal-Wallis 1-way ANOVA test for testing the differences between group mean scores. Data entered as a text (string variables) were converted into categorical (ordinal) variables using the Automatic Recode SPSS feature. The predictive value of self-reported state persecutory ideation was examined using linear regressions. The Mann-Whitney U analysis was used to test for schizotypy differences between 2 groups at time. The Bonferroni adjustment to the alpha value was applied to compare each group with one another (high schizotypy with moderate, high with low and moderate with low). The revised alpha level of .05/3=.017 was used to determine significance. The effect size of differences in schizotypy was calculated using the standardized tests. The guidelines elaborated by Cohen (1988) were used to determine the strength of the relationship, with .1 being small, .3 medium and .5 large.

10. Results

10.1. SPQ scores breakdown

Table 5 summarises the SPQ means and standard deviations for the high, moderate and low schizotypy group.

Table 5. SPQ means, standard deviations and main effect of groups' differences in self-reported schizotypy scores using the Kruskal-Wallis Test

Scale	High Schizotypy N=16	Moderate Schizotypy N=16	Low Schizotypy N=13	Chi squared statistic (df = 2, n = 45)
	Mean (SD, range)	*Mean (SD, range)*	*Mean (SD, range)*	
SPQ^{TOT}	30.56 (9.09, 17-56)	17.88 (4.11, 12-24)	3.85 (2.97, 0-8)	35.89**
SPQ subscales				
Ideas of reference	4.44 (2.39, 0-8)	2.75 (1.61, 0-5)	.23 (.60, 0-2)	24.61**
Excessive Social Anxiety	3.88 (2.75, 0-8)	3.13 (2.19, 0-8)	1.15 (1.14, 0-3)	9.37*
Odd Beliefs or Magical Thinking	1.88 (1.75, 0-6)	.94 (1.06, 0-4)	.46 (1.13, 0-4)	7.76*
Unusual Perceptual Experiences	3.50 (2.07, 0-7)	1.19 (1.05, 0-3)	.08 (.28, 0-1)	25.56**
Odd or Eccentric Behaviour	2.94 (2.11, 0-7)	1.44 (1.37, 0-4)	0 (0, 0)	21.71**
No Close Friends	2.88 (2, 0-6)	2.25 (1.69, 0-5)	.15 (.38, 0-1)	19.75**
Odd Speech	4.81 (1.94, 2-9)	2.25 (1.53, 0-5)	1.23 (1.3, 0-4)	21.53**
Constricted Affect	2.19 (1.28, 0-4)	1.69 (1.08, 0-4)	.23 (.44, 0-1)	19.56**
Suspiciousness	4.06 (2.05, 0-8)	2.25 (.86, 1-3)	.31 (.48, 0-1)	27.92**

SPQ, Schizotypal Personality Questionnaire.

**p<.001, *p<.05

As expected, the three groups significantly differed in regard to the schizotypy total scores and its subscales.

10.2. Groups' differences in self-reported schizotypy scores

Table 6 summarises the difference between groups.

Table 6. Pair-wise groups' differences in self-reported schizotypy scores using Mann-Whitney U Test

	Moderate Schizotypy N=16	**Low Schizotypy N=13**
High Schizotypy N=16	U=18.5, z=-4.14*, r=.7	U= 0, z=-4.57*, r=.8
Moderate Schizotypy N=16	-	U=0, z=-4.57*, r=.8

*p<.017

All differences outlined from the pairwise groups' comparisons were significant p<.017) with larger effect size r ≥ .7.

10.3. High, moderate and low schizotypy groups' characteristics

The mean age for high schizotypy was 28.31 (SD 7.04, range 18-44), for moderate schizotypy was 29.25 (SD 13.02, range 18-58) and for low schizotypy was 29.08 (SD 11.51, range 20-64). In all groups, the majority of the participants were white. Table 7 summarises demographic characteristic of high, low and moderate schizotypy groups.

Table 7. Demographic characteristics of high, moderate and low schizotypy groups in VR study and main effect of groups' differences using the Kruskal-Wallis Test

Demographic	**High Schizotypy N=16**	**Moderate Schizotypy N=16**	**Low Schizotypy N=13**	**Chi squared statistic (df = 2, n = 45)**
	Mean (SD, range)	*Mean (SD, range)*	*Mean (SD, range)*	
Age (years)	28.31 (7.04, 18-44)	29.25 (13.02, 18-58)	29.08 (11.51, 20-64)	27.92*
	N (%)			
Gender				7.32**
Females	8 (50%)	15 (93.75%)	9 (69.23%)	
Males	8 (50%)	1 (6.25%)	4 (30.77%)	

Ethnicity				13.06***
White	8 (50%)	10 (62.5%)	10 (76.93%)	
Asian/ Asian British	4 (25%)	2 (12.5%)	1 (7.69%)	
Mixed/ Multiple ethnic groups	1 (6.25%)	2 (12.5%)	-	
Other ethnic group	1 (6.25%)	1 (6.25%)	2 (15.38%)	
Black/ African/ Caribbean/ Black British	2 (12.50%)	1 (6.25%)	-	
Level of education				8.44**
Undergraduate degree	9 (56.25%)	7 (43.75%)	6 (46.16%)	
AS, A-levels, (G)NVQ	2 (12.5%)	4 (25%)	-	
Masters degree	3 (18.75%)	4 (25%)	5 (38.46%)	
Doctorate, PhD	2 (12.5%)	1 (6.25%)	1 (7.69%)	
O-Levels, GCSEs, GCEs	-	-	1 (7.69%)	
No formal qualifications	-	-	-	
Employment Status				21.33*
Student	6 (37.5%)	12 (75%)	5 (38.46%)	
Full-time paid employment	10 (62.5%)	4 (25%)	5 (38.46%)	
Part-time paid employment	-	-	2 (15.39%)	
Unemployed	-	-	1 (7.69%)	
Other	-	-	-	
Relationship/marital status				9.53**
Single	6 (37.5%)	8 (50%)	6 (46.16%)	
Cohabiting	6 (37.5%)	4 (25%)	5 (38.46%)	
In a relationship	-	2 (12.5%)	1 (7.69%)	
Married	2 (12.5%)	2 (12.5%)	1 (7.69%)	
Other	2 (12.5%)	-	-	
Separated	-	-	-	
Divorced	-	-	-	
Living arrangements				p=.09
I am renting a house/flat	8 (50%)	9 (56.25%)	6 (46.16%)	

I am renting a room in house share	2 (12.5%)	4 (25%)	5 (38.46%)	
I live with my parents	-	-	1 (7.69%)	
I own the house/flat where I am living	4 (25%)	2 (12.5%)	-	
Other	2 (12.5%)	-	-	
I am renting a bed-sit	-	1 (6.25%)	1 (7.69%)	
I am staying in a hostel	-	-	-	

*p<.001, **p<.05, ***p<.01

Groups' differences for age, gender, ethnicity, level of education, employment status, relationship status were statistically significant. Groups' differences for living arrangements were not statistically significant.

The 45 individuals found out about the study in different ways. In the high schizotypy group both online and offline methods were equally used, whereas in the moderate group more than half accessed the study through online platforms. The opposite occurred in the low schizotypy group, where the majority of people seemed to prefer offline channels.

Table 8 summarises the ways participants found out about the study.

Table 8. VR participant recruitment sources and related main effect of groups' differences using the Kruskal-Wallis Test

Way of finding out about study	High Schizotypy N=16	Moderate Schizotypy N=16	Low Schizotypy N=13	Chi squared statistic (df = 2, n = 45)
Online	8 (50%)	11 (68.75%)	6 (46.15%)	.47
Offline	8 (50%)	5 (31.25%)	7 (53.85%)	

The differences between groups regarding the way of finding out about the study were not statistically significant.

Table 9 summarises participants' VR and gaming experience.

Table 9. Participants' previous used of VR and gaming experience and related main effect of groups' differences using the Kruskal-Wallis Test

VR and gaming experience	High Schizotypy N=16	Moderate Schizotypy N=16	Low Schizotypy N=13	Chi squared statistic (df = 2, n = 45)
Previous used VR (%)	11 (68.75%)	11 (68.75%)	8 (61.54%)	.90
Play computer games regularly (%)	3 (18.75%)	1 (6.25%)	2 (15.38%)	.57

Groups' differences regarding previous used of VR and experience of gaming were not statistically significant.

11. Pre-VR and post-VR self-report measures analyses

11.1. Pre-VR self-report measures

The breakdown of the scores reported by each group for each pre-VR questionnaires are summarised in table 10.

Table 10. Pre-VR self-report measures means, standard deviations, range of scores and main effect of groups' differences in self-reported interpersonal sensitivity and trait paranoid ideation scores using the Kruskal-Wallis Test

Scale	High Schizotypy N= 16	Moderate Schizotypy N= 16	Low Schizotypy N= 13	Chi squared statistic (df = 2, n = 45)
	Mean (SD, range)	*Mean (SD, range)*	*Mean (SD, range)*	
IPSM tot	97.06 (12.31, 78-120)	90 (16.63, 60-120)	89.15 (11.02, 70-110)	.26
IPSM subscales				
Interpersonal awareness	20 (3.46, 15-26)	18.56 (5.50, 10-28)	18.15 (4.22, 10-24)	.60
Need for approval	26.38 (2.39, 21-29)	25.56 (3.10, 18-29)	26.62 (1.80, 24-30)	.78
Separation anxiety	19.06 (3.66, 14-28)	17.75 (4.85, 10-26)	15.62 (4.01, 10-22)	.09

Timidity	21.06 (4.02, 13-26)	18.88 (4.15, 10-25)	20.69 (2.43, 17-27)	.35
Fragile inner-self	10.56 (2.28, 7-14)	10.06 (5-16)	8.08 (2.56, 5-12)	.05
Paranoia Scale	45.81 (11.89, 24-65)	41.44 (11.79, 22-60)	27 (4.10, 21-35)	17.35*

IPSM, Interpersonal Sensitivity Measure.
*p<.05

Groups' differences for IPSM scores were not statistically significant. Of note, all groups' IPSM total scores were clustered around the median score of the IPSM scale (a score of 90 represents the median of the IPSM). This was also reflected in the IPSM total mean score for the whole sample of 45 participants: mean 92.56 (S.D. 13.82, range 60-120).

The differences noted between groups on the Paranoia Scale were statistically significant, with the high and the moderate schizotypy groups reporting higher levels of trait paranoid ideation in comparison to the low group (see Table 11). The Paranoia Scale mean scores for both high and moderate schizotypy groups were just above the 25th percentile of the scale (a score of 40 represents the 25th percentile of the scale). When examining the range of scores for these two groups, some participants scored above the median (a score of 60 represents the 50th percentile of the scale). The Paranoia Scale mean reported by the low schizotypy group fell below the 25th percentile of the scale; none of the scores given by the participants in this group were above the median. In the whole sample of 45 participants the mean for the Paranoia Scale was 38.40 (S.D. 13.02, range 20-65).

Table 11 shows groups' differences on trait paranoia ideation, as measured by the Paranoia Scale, and related size effects.

Table 11. Pair-wise groups' differences in self-reported trait paranoia ideation scores using Mann-Whitney U Test

	Moderate Schizotypy N=16	**Low Schizotypy N=13**
High Schizotypy N=16	U=106, z=-.83, p=.41, r=.15	U=19, z=-3.73*, r=.69

Moderate Schizotypy N=16	-	U=25, z=-3.47*, r=.64

*p<.017

There was no significant difference between the high and moderate schizotypy groups on trait of paranoid ideation at baseline. There was a significant difference between the high (Md=20.31, n=16) and low (Md= 8.46, n=13) schizotypy groups, U=19, z=-3.73, p<.017 with a large size effect (r=.78). The test also showed a significant difference between the moderate (Md=19.94, n=16) and low (Md=8.92, n=13) schizotypy groups on trait of paranoid ideation, U=25, z=-3.47, p<.017 with a large size effect (r=.64).

Table 12 illustrates the reliability analyses for all pre-VR self-report measures, including the SPQ, for the sample of 45 participants.

Table 12. Pre-VR self-report measures' reliability

Scale	Total sample N= 45
SPQ^{TOT}	.93
SPQ subscales	
Ideas of reference	.77
Excessive Social Anxiety	.81
Odd Beliefs or Magical Thinking	.69
Unusual Perceptual Experiences	.77
Odd or Eccentric Behaviour	.80
No Close Friends	.69
Odd Speech	.73
Constricted Affect	.39
Suspiciousness	.69
IPSM^{TOT}	.89
IPSM subscales	
Interpersonal awareness	.84
Need for approval	.40
Separation anxiety	.77
Timidity	.71
Fragile inner-self	.64

Paranoia Scale	.91

SPQ, Schizotypal Personality Questionnaire; IPSM, Interpersonal Sensitivity Measure.

With the exception of the subscale constricted affect^{SPQ} (Cronbach alpha .39) and Need for approval^{IPSM} (Cronbach alpha .40), all pre-VR measures reported adequate internal consistency.

11.2. Post-VR self-report measures

The breakdown of the scores reported by each group for VAS measures and state paranoid ideation are summarised in table 13.

Table 13. Post-VR self-report measures means, standard deviations, range of scores and main effect of groups' differences in self-reported sense of presence and enjoyment during VR and SSPS subscales scores using the Kruskal-Wallis Test

Scale	High Schizotypy N= 16	Moderate Schizotypy N= 16	Low Schizotypy N= 13	Chi squared statistic (df = 2, n = 45)
	Mean (SD, range)	*Mean (SD, range)*	*Mean (SD, range)*	
Sense of Presence^{VAS}	6.25 (2.24, 3-9)	5.81 (2.20, 1-9)	5.69 (2.75, 1-10)	.82
Enjoyment^{VAS}	7.37 (1.59, 4-10)	6.75 (2.86, 1-10)	7.46 (1.98, 4-10)	.86
SSPS subscales				
Persecutory Ideation	17.81 (7.07, 10-34)	18.63 (7.33, 10-38)	19 (7.19, 10-32)	.90
Neutral Ideation	12.63 (3.20, 8-21)	11.94 (4.45, 5-21)	11.77 (2.35, 7-16)	.84
Positive Ideation	15.88 (3.54, 11-24)	14.25 (3.61, 9-21)	15.08 (3.01, 10-21)	.46

VAS, Visual Analogue Scales; SSPS, State Social Paranoia Scale.

Table 14 illustrates the reliability analysis for post-VR SSPS measure.

Table 14. Post-VR self-report measures' reliability

Scale	Total sample N= 45
SSPS subscales	
Persecutory Ideation	.866
Neutral Ideation	.489
Positive Ideation	.658

11.3. The correlation of schizotypy with interpersonal sensitivity and trait paranoid ideation (hypothesis 1)

Spearman rho correlations, used to test hypothesis 1 [higher levels of schizotypy will be associated with higher interpersonal sensitivity and higher levels of trait paranoid ideation.] revealed a statistically significant positive correlation between schizotypy SPQ^{TOT} and interpersonal sensitivity $IPSM^{TOT}$ scores with medium effect size ($r= .44$, $p<.01$) and between schizotypy SPQ^{TOT} and the Paranoia Scale ($r=.46$, $p<.01$) with medium size effect. Therefore, we can conclude that hypothesis 1 was supported. See Table 15.

Table 15. The correlations of SPQ with IPSM and the Paranoia Scale

Scale	SPQ tot	Ideas of reference^{SPQ}	Excessive Social Anxiety^{SPQ}	Odd Beliefs or Magical Thinking^{SPQ}	Unusual Perceptual Experiences^{SPQ}	Odd or Eccentric Behaviour^{SPQ}	No Close Friends^{SPQ}	Odd Speech^{SPQ}	Constricted Affect^{SPQ}	Suspiciousness^{SPQ}
The Paranoia Scale	.46**	.28	.43**	.02	.27	.28	.45**	.26	.41**	.60**
IPSM^{TOT}	.44**	.31*	.48**	.13	.44**	.26	.43**	.30*	.08	.23
Interpersonal awareness^{IPSM}	.33*	.29	.48**	.06	.35*	.14	.26	.16	.001	.15
Need for approval^{IPSM}	.19	.12	.17	.36*	.33*	.13	.03	.18	-.03	.06
Separation anxiety^{IPSM}	.46**	.42**	.46**	.06	.41**	.28	.48**	.32*	.15	.24
Timidity^{IPSM}	.28	.04	.36*	.06	.24	.19	.05	.30*	.03	.14
Fragile inner-self^{IPSM}	.44**	.30*	.32*	.09	.38*	.31*	.57**	.27	.20	.26

SPQ, Schizotypal Personality Questionnaire; IPSM, Interpersonal Sensitivity Measure.

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The correlations between the SPQ total score and IPSM subscales revealed positive significant correlation with three out of five IPSM subscales: interpersonal awareness^{IPSM} (r=.33, p<.05), separation anxiety^{IPSM}, (r=.46, p<.01) and fragile inner-self^{IPSM} (r=.44, p<.01), all with a medium size effect. Similarly, the IPSM^{TOT} had positive and significant correlations with five out of nine SPQ^{TOT} subscales: ideas of reference^{SPQ} (r=.31, p<.05), excessive social anxiety^{SPQ} (r=.48, p<.01), Unusual perceptual experiences^{SPQ} (r=.44, p.<01), no close friends^{SPQ} (r=.43, p<.01) and odd speech^{SPQ} (r=.30, p<.05).

The significant and positive correlation that the subscale fragile inner-self^{IPSM} has with both the ideas of reference^{SPQ} (r=.30, p<.05) and unusual perceptual experiences^{SPQ} (r=.38, p<.05) SPQ subscales, are in line with the findings of previous studies describing fragile inner-self to be associated with paranoid ideation in general populations (Freeman et al. 2008a).

Interestingly, the suspiciousness subscale of the SPQ did not correlate significantly with either the IPSM^{TOT} scale or any of its subscales; however, it had a strong positive correlation with the Paranoia Scale (r=.60, p<.01). No statistically significant negative correlations were noted and all the positive significant correlations had either a medium or large size effect.

11.4. VR exposure and state persecutory ideation (hypothesis 2)

The findings discussed in this paragraph aim to answer research question 2: does exposure to the VR environment elicit state persecutory ideation? From the results illustrated in table 13, it is possible to deduce that the VR environment triggered mild state persecutory ideation as well as neutral and positive ideation. Although the VR environment was created to be perceived as neutral, some participants in each of the groups reported heightened state persecutory ideation scores, above the median of the persecutory ideation^{SSPS} subscale (a score of 30 represents the 50th percentile of the persecutory ideation^{SSPS} subscale). In the entire sample of 45 participants, the mean for the persecutory ideation^{SSPS} subscale was 18.44 (S.D. 7.05, range 10-38).

These findings are in line with recent qualitative studies investigating subjective experience of paranoia in VR in a healthy sample of individuals with high trait paranoid ideation (Riches et al. 2020), indicating the presence of moderate attenuated paranoid experiences amongst healthy participants with half reporting ideas of persecution. The attribution of persecutory significance and mental states to neutral VR stimuli in non-clinical samples has also been investigated and supported by previous empirical studies and systematic reviews (Freeman et al. 2003; Valmaggia et al. 2016a). It is therefore possible to conclude that, hypothesis 2, that exposure to VR would elicit state persecutory ideation, was supported.

11.5. Predictors of state persecutory ideation (hypotheses 3 and 4)

To test hypotheses 3 and 4 a multiple regression analysis was used to predict the scores on the persecutory subscale of the SSPS measuring state persecutory ideation from the scores on SPQ, IPSM and Paranoia Scale. This analysis aimed to answer research questions n. 3 and n. 4:

- *Question 3:* Do higher baseline schizotypy traits predict higher state persecutory ideation as induced by the VR environment?
- *Questions 4:* Do higher interpersonal sensitivity traits predict higher state persecutory as induced by the VR environment?

The results regarding state persecutory ideation^{SSPS} are illustrated in table 16.

Table 16. Predictors of State Persecutory Ideation^{SSPS}

Dependent Variable	R	Adjusted R Square	Test
State Persecutory Ideation^{SSPS}	.28[a]	.011	F(3, 41) = 1.16, p=.34

a. Predictors: SPQ^{TOT} (Schizotypal Personality Questionnaire), IPSM^{TOT} (Interpersonal Sensitivity Measure), The Paranoia Scale^{TOT}

Baseline SPQ^{TOT}, IPSM^{TOT} and the Paranoia Scale scores did not predict the variance in state in persecutory ideation^{SSPS} scores (p=.34).

11.6. Summary of main findings of Study 1

The aim of *Study 1* was to investigate the relationship of schizotypy with interpersonal sensitivity and trait paranoid ideation and whether they predicted increased state persecutory ideation in VR. This study also investigated whether exposure to the VR environment would elicit state persecutory ideation. A positive correlation (with medium size effect) was found between SPQ and the Paranoia Scale ($r=.46$, $p<.01$) and between SPQ and IPSM scales ($r=.44$, $p<.01$), supporting hypothesis 1. Exposure to VR elicited mild state persecutory ideation, therefore hypothesis 2, that exposure to VR would elicit state persecutory ideation was supported.

The trait schizotypy, interpersonal sensitivity, and paranoid ideation did not significantly predict state paranoid ideation induced by the VR experience, not confirming hypotheses 3 and 4. In regard to hypothesis 4, it is possible that the lack of correlation between the two variables could be explained by the high interpersonal sensitivity mean scores reported across all groups. The IPSM mean scores clustered above or around the 50th percentile of the IPSM scale may explain the lack of effect of the independent variable (IPSM) on the dependent variable (persecutory ideation^{SSPS} subscale).

All participants across the three groups felt sufficiently present in the virtual environments, as measured by the presence^{VAS} scale (range 1–10): high schizotypy (mean 6.25), moderate (mean 5.81), and low (mean 5.69) and they all reported enjoyment levels above the mean, as measured by the enjoyment^{VAS} scale (1-10): high schizotypy (mean 7.37), moderate schizotypy (mean 6.75), and low schizotypy (mean 7.46).

12. Discussion

The positive significant correlation of schizotypy with both interpersonal sensitivity and trait paranoid ideation is in line with findings of previous studies demonstrating the association between positive schizotypy traits, such as paranoid and state persecutory

ideation, and preoccupations related to the evaluation of self in social context (Martin et al. 2001). The findings of the present study demonstrated the fragile inner-self^{IPSM} subscale to be positively correlated with the unusual perceptual experiences^{SPQ} and ideas of reference^{SPQ} subscales, which Freeman et al. (2008b) has identified as increasing factors of paranoid reactions.

12.1. Strengths

To our knowledge, this is the first study to investigate the relationship of schizotypy with both interpersonal sensitivity (as measured by IPSM) and trait paranoid ideation (as measured by the Paranoia Scale) and whether these constructs predicted state persecutory ideation (as measured by the persecutory ideation^{s} subscale). Therefore, the key strength of the study is that it provides preliminary novel information regarding the association between these constructs and their ability to predict state paranoid ideation elicited by an ecologically valid and standardised VR social environment. Potential confounding variables, such as living arrangements, previous use of VR and experience of gaming, ways of finding out about the study and completion of the study, were controlled by the study. Groups' differences for trait paranoid ideation were statistically significant.

12.2. Limitations

The sample used in this study was mainly recruited through university channels and leaflets disseminated in the areas within the London Borough of Southwark and City of Westminster. Therefore, it is possible that the sample was not accurately representative of the general population as it shared characteristics that did not align with the entire population group. The findings may not generalise to older adults and people in non-academic settings.

The way the study was advertised might have also influenced how participants perceived and responded to the SPQ questionnaires. Furthermore, despite the three researchers involved in the recruitment of participants using the instruction manual for

data collection to enhance consistency in practise, it is possible that experimenter effects and changes in the experimenters' demeanour may have affected the way participants behaved in the VR environment. Not all the scales showed adequate internal consistency.

STUDY 2. Establishing the test-retest reliability of the VR environment on inducing state persecutory ideation.

13. Introduction

The aim of *Study 2* was to establish the test-retest reliability of the VR environment on inducing state persecutory ideation.

Research Question 1: Can the same VR environment be used to assess state persecutory ideation after an interval of 40 days?

VR test-retest reliability will be explored with an open-ended approach (i.e. not-hypothesis based), as either habituation or sensitisation effects could occur.

14. Method

14.1. Design

Repeat measures comparison cross sectional design.

14.2. Participants

The 45 participants selected in *Study 1* were re-invited to take part in the second VR-session after 40 days. The second appointment was scheduled during the first laboratory-based appointment. Participants were then sent two reminders, via text or email, one week and one day prior to their second appointment. See Appendix XIV.

14.3. Pre-VR self-report measures

Participants completed the *Stress, Anxiety, Sadness, and Happiness Visual Analogue Scales (VAS*). This self-report measure was not included in this study.

14.4. Post-VR self-report measures

State Social Paranoia Scale (SSPS). SSPS measures paranoid ideation about a social situation (Freeman et al. 2007). It is composed of 20-items measured on a 5-point scale, from 1 ('Do not agree') to 5 (Totally agree). Higher scores indicate greater level of persecutory thinking. The scale assesses persecutory ideation (10 items, range 10-50), neutral ideation (5 items, range 5-25) and positive (5 items, range 5-25) ideation about the avatars. It demonstrated good psychometric properties. Sample items include 'Someone was hostile towards me' and 'No-one had any particular feelings about me'. As in *Study 1*, only the scores reported by the SSPS subscale measuring state persecutory ideation were included in this study.

Visual Analogue Scales (VAS) to measure components of social performance and mood. As in *Study 1*, only the results from the VAS scales examining the sense of presence and enjoyment experienced by participants during VR were included in this study

The same short audiotaped semi-structured interview administered in *Study 1* was re-administered in *Study 2*. See Appendix XII. The information gathered from the audio-recordings was not included in this study.

14.5. Online surveys

Two different online surveys (Online surveys formerly BOS) were created for the pre and post VR in Study 2. See Appendixes IX and X for online surveys output.

14.6. Study's components

All of the procedures, materials, instructions and VR apparatus used were identical to *Study 1.*

14.7. Statistical analysis strategy

All statistical analyses were carried out through SPSS Version 25 (SPSS Inc., Chicago, USA; www.spss.com). Nonparametric measures were used when normality was violated. Groups' mean scores comparisons were calculated using the Kruskal-Wallis Test. Test-retest reliability analyses were carried out using correlation analyses. Paired samples t-test between *Study 1* and *Study 2* were analysed using the Wilcoxon Signed Rank Test.

15. Results

The breakdown of the scores for each post-VR self-report measures for the three groups are summarised in table 17.

Table 17. Post-VR self-report measures means, standard deviations, range of scores and main effect of groups' differences in self-reported sense of presence and enjoyment during VR and SSPS subscales scores using the Kruskal-Wallis Test

Scale	High Schizotypy N= 16	Moderate Schizotypy N= 14	Low Schizotypy N= 13	Chi squared statistic (df = 2, n = 43)
	Mean (SD, range)	*Mean (SD, range)*	*Mean (SD, range)*	
Sense of Presence^{VAS}	6.06 (1.77, 3-9)	5.14 (2.93, 1-9)	5.77 (2.68, 1-9)	.75
Enjoyment^{VAS}	7.56 (1.79, 4-10)	6.28 (2.72, 2-10)	6.31 (2.06, 3-7)	.20
SSPS subscales				
Persecutory Ideation	17.38 (6.68, 10-33)	18.79 (8.87, 10-38)	22.08 (9.96, 10-37)	.48
Neutral Ideation	11.63 (3.44, 6-18)	12.79 (4.87, 5-20)	10.69 (4.17, 5-20)	.47
Positive Ideation	15.69 (3.55, 10-22)	14.21 (2.69, 9-19)	14.62 (3.07, 9-20)	.54

VAS, Visual Analogue Scales; SSPS, State Social Paranoia Scale.

*p<.05 (all p-values 2-sided test)

Groups' differences for state social paranoia were not statistically significant. Similarly to *Study 1* some participants in each of the groups reported heightened state persecutory

ideation scores, above the median of the persecutory ideation^{SSPS} subscale (a score of 30 represents the 50th percentile of the persecutory ideation^{SSPS} subscale).

Table 18 illustrates the internal consistency of the post-VR SSPS.

Table 18. Post-VR SSPS scale's internal consistency

Scale	Total sample N= 43
SSPS subscales	
Persecutory Ideation	.915
Neutral Ideation	.771
Positive Ideation	.618

SSPS, State Social Paranoia Scale.

The groups did not differ in regard to study completion. The findings are illustrated in table 19.

Table 19. VR task completion rates and related main effect of groups' differences using the Kruskal-Wallis test

Completion of study	High Schizotypy N=16	Moderate Schizotypy N=16	Low Schizotypy N=13	Chi squared statistic (df = 2, n = 45)
Participant completed VR tasks (%)	16 (100%)	14 (87.5%)	13 (100%)	.16

15.1. VR test-retest reliability

Table 20 illustrates the comparisons between post-VR SSPS scores after completion of *Study 1* and *Study 2*.

Table 20. Post-VR Study 1 and Post-VR Study 2 SSPS subscales means, standard deviations and main effect of time differences using the Wilcoxon Signed Rank Test, SSPS subscales test-retest reliability using Cronbach's Alpha

SSPS	STUDY 1 POST-VR N=43 *Mean (SD)*	STUDY 2 POST-VR N=43 *Mean (SD)*	Wilcoxon Signed Rank Test	Effect size	Reliability Statistics Cronbach's Alpha

SSPS subscales					
Persecutory Ideation	18.51 (7.13)	19.26 (8.52)	z = -.65, p = .51	r = .07	.8
Neutral Ideation	12.19 (3.49)	11.72 (4.15)	z = -1.09, p = .28	r = .12	.7
Positive Ideation	15.14 (3.46)	14.88 (3.14)	z = -.57, p = .57	r = .06	.7

SSPS, State Social Paranoia Scale.

Groups' differences for state persecutory ideation were not statistically significant. All subscales of the SSPS show good (≥ .7) Cronbach's alpha coefficients.

15.2. Summary of main findings of Study 2

The aim of *Study 2* was to investigate the test-retest reliability of the VR environment on inducing state persecutory ideation and whether habituation or sensitisation effects occurred. This study was an estimation study and therefore not driven by hypotheses.

Out of the 45 participants who attended the first VR appointment, 43 completed *Study 2*: two participants from the moderate schizotypy group were unable to attend the second study. The groups did not report any statistically significant differences prior to the VR-tasks. Significant groups' differences were only observed following VR exposure.

Similarly to *Study 1*, all participants across the three groups felt sufficiently present in the VR environment, as measured by the presence^{VAS} scale (range 1–10): high schizotypy (mean 6.06), moderate (mean 5.14), and low (mean 5.77) and they all reported enjoyment levels above the mean, as measured by the enjoyment^{VAS} scale (0-10): high schizotypy (mean 7.56), moderate (mean 6.28), and low (mean 6.31).

15.3. Test-retest reliability findings

A Wilcoxon Signed Rank Test revealed no statistically significant differences (either reduction or increase) in state persecutory ideation following a second exposure to the same VR environment, z = -1.09, p = .28. It is therefore possible to conclude that the VR social situation task used in this study can be used to re-assess people at follow-up.

16. Discussion

This study aimed to establish the test-retest reliability of the VR environment on inducing state persecutory ideation. Our findings did not find statistically significant changes in state persecutory ideation, suggesting that the VR social task used in this research has demonstrated a good test-retest reliability and ensured that the measurements obtained in one sitting were both representative and stable over time. This preliminary evidence suggests that VR has the potential to be used as an objective assessment tool for treatment efficacy and for changes in persecutory ideation tendencies in a healthy population.

16.1. Strengths

A key strength of this study is that it investigates the test-retest reliability of a new VR social situation task. Most of the participants (43 of 45) completed *Study 2*. All scales showed good Cronbach values.

16.2. Limitations

Factors that could have affected the study's validity were the repeating testing and the ways the researchers conducted both laboratory-based studies. These factors might have influenced participants' behaviours.

17. Overall summary

Study 1 aimed to examine the association of schizotypy (as measured by SPQ) with both interpersonal sensitivity (as measured by IPSM) and trait paranoid ideation (as measured by the Paranoia Scale) and whether they predicted state persecutory ideation (as measured by the state persecutory ideation^{SSPS} subscale) induced by VR. This study also aimed to establish whether exposure to VR elicited state persecutory ideation.

An online survey of the general population was conducted in order identify three groups with different schizotypy profiles: high, moderate and low. The data from the three groups were analysed to establish whether the VR social situation task elicited greater state persecutory ideation in those who reported heightened schizotypy and interpersonal sensitivity scores at baseline.

Study 2 aimed to establish the test-retest reliability of the VR environment on inducing state persecutory ideation. The test-retest reliability was investigated with an open-ended approach, as either habituation or sensitisation effects could have occurred.

Study 1 showed that schizotypy was positively correlated with both trait paranoid ideation and interpersonal sensitivity but none of these three constructs predicted state persecutory ideation following exposure to VR. VR was found to elicit moderate state persecutory ideation, alongside neutral and positive. In line with previous studies (Freeman et al. 2008a), the fragile inner-self^{IPSM} subscale demonstrated a significant positive correlation with some of the SPQ subscales: ideas of reference^{SPQ} and unusual perceptual experiences^{SPQ}. *Study 2* supported VR test-retest reliability in assessing state persecutory ideation in healthy individuals.

18. Limitations

In addition to what has been previously outlined, this study demonstrates further limitations. Several other factors could have affected the results. Firstly, despite some studies (Cohen et al. 2009) investigating schizotypal traits in healthy adult populations have reported significant differences between groups in regard to the disorganised, negative and overall schizotypy domains based on gender, ethnicity and age, this research did not explore the possible effects of demographic and clinical confounder; therefore, the possibility that these variables might have influenced group differences could not be ruled out.

Secondly, three schizotypy dimensions (positive, negative and disorganised) might correlate differently with trait paranoid ideation, and, therefore, have different value in

predicting persecutory ideation induced by the VR environment. With some longitudinal studies demonstrating both the positive and negative schizotypy domains to be significantly associated with the development of schizophrenia-spectrum disorders (Kwapil et al. 2013) and others highlighting the correlation between the paranoia SPQ subscale with both positive and negative SPQ dimensions (Raine et al. 1994), it is important for future research to focus on exploring the association of specific schizotypy subscales (e.g., paranoia) and dimensions (e.g., positive) with the investigated constructs (e.g., trait paranoid ideation and/or state persecutory ideation) rather than the overall schizotypy score.

Thirdly, the investigation of schizotypy by group could have reduced the study's statistical power. The small group sizes might have prevented analyses from detecting statistically significant findings when they truly existed. The real-life measurements used might also have affected the quality of the study's results due to the influence of extraneous uncontrolled variables.

Furthermore, literature investigating the way schizotypy is assessed reports that scales with Likert-type response usually improves the psychometric properties of the test when compared to dichotomous response format (T/F, Yes/No). It is possible that the yes and no response design used in this study may have limited the way the SPQ scale captured the sample's schizotypy profile (Fonseca-Pedrero et al. 2008). Furthermore, it is important to acknowledge that the general population from which the sample had been recruited, contains a wide range of many subclinical and clinical conditions, often unknown to the person, that may have influenced the way some participants answered the self-report SPQ questionnaire and/or interacted in the VR environment. The participants in the high schizotypy group (N=16) were those who scored the highest in this study's sample (N=181) but are not necessarily high schizotypy in the absolute terms. Therefore, it is possible that the sample of 181 individuals selected for this study may be representative of the lower end of the schizotypy continuum in the general population and therefore not fully representative of the entire distribution of schizotypy.

19. Clinical implication and future research

This research sets some preliminarily directions for future studies and provides novel information regarding the effectiveness of VR in assessing state persecutory ideation over time. Building on previous research (Riches et al. 2019), it demonstrates that VR has the potential to be used in the assessment of state persecutory ideation in healthy populations and to be a feasible and well-accepted tool. It also shows that VR has a good test-retest reliability in measuring state persecutory ideation at follow up, suggesting its potential use as an objective assessment measure.

Future studies may expand on these findings by exploring the test-retest reliability of VR in clinical populations, with the aim to investigate its effectiveness of objectively evaluating treatment outcomes and persecutory ideation tendencies following psychotherapeutic and/or pharmacological interventions. Furthermore, with the positive schizotypy domain being linked with psychosis-like psychopathology (Kwapil et al. 2008) and the ideas of reference subscale of the SPQ being described as a strong predictor for transition to psychosis (Salokangas et al. 2013), future studies could investigate the association of positive schizotypy with both trait paranoid and state persecutory ideation through the use of an ecologically valid VR environment. This may help clinicians to better understand the trajectories of specific cognitive thinking styles (e.g., suspiciousness and persecutory thinking) and their variations in severity and prevalence.

The findings of this study were not robust enough to draw meaningful conclusions on whether the use of VR could improve the rigor in investigating whether self-reported schizotypy and interpersonal sensitivity traits predict state persecutory ideation elicited by a VR immersive social environment. However, the good VR test-retest reliability demonstrated in this study, suggests that VR has the potential to provide meaningful relationships between self-reported traits, based on people's beliefs of themselves, and state, objectively experienced in a VR environment.

Future research exploring similar constructs could overcome some of the limitations of this study by recruiting bigger samples to maximise reliability, reduce lack of power and enhance the sample's representativeness of the schizotypy spectrum and place more focus on the positive domain of the schizotypy construct. This may help researchers to better identify the underlying mechanisms and personality traits involved in the aggravation of psychotic symptoms.

Literature has described the schizotypy construct as a combination of personality, environmental and genetic variations (Kwapil et al. 2015), therefore the implementation of elements investigating social and clinical functioning within VR tasks, may improve the potential of VR to better capture the complexity of schizotypy and its full phenotypic expression. Furthermore, future studies could also investigate the role of participants' demographic characteristics in the relationship between schizotypy, interpersonal sensitivity and trait paranoid ideation.

20. Conclusion

The findings of this study suggest that schizotypy has a positive correlation with both interpersonal sensitivity and trait paranoid ideation (medium effect size) and VR has the potential to elicit some degree of state persecutory ideation in healthy individuals with heightened schizotypy traits. Repeated exposure to the same VR environment did not produce either habituation or sensitisation effects on state persecutory ideation suggesting VR to have good test-retest reliability in assessing the same construct over time.

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22. Declarations of Interest

None

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24. References

Barrantes-Vidal, N., Gross, G. M., Sheinbaum, T., Mitjavila, M., Ballespí, S., Kwapil, T. R. (2013). Positive and negative schizotypy are associated with prodromal and schizophrenia-spectrum symptoms. *Schizophrenia Research,* 45, 50-55.

Birnbaum, M. H. (2001). *Introduction to Behavioural Research on the Internet.* Englewood Cliffs, NJ: Prentice-Hall.

Boyce, P., Mason, C. (1996). An overview of depression-prone personality traits and the role of interpersonal sensitivity. *Australian & New Zealand Journal of Psychiatry,* 30, 90–103

Boyce, P., Parker, G. (1989). Development of a scale to measure interpersonal sensitivity. *Australian and New Zealand Journal of Psychiatry,* 23, 341–351.

Broome, M. R., Woolley, J. B., Tabraham, P., Johns, L. C., Bramon, E., Murray, G. K., Pariante, C., McGuire, P. K., Murray, R. M. (2005). What causes the onset of psychosis? *Schizophrenia Research,* 79, 23–34.

Cannon, T. D., Cadenhead, K., Cornblatt, B., Woods, S. W., Addington, J., Walker, E., Seidman, L. J., Perkins, D., Tsuang, M., McGlashan, T., Heinssen R. (2008). Prediction of Psychosis in Youth at High Clinical Risk: A Multisite Longitudinal Study in North America. *Archives of General Psychiatry,* 65(*1*), 28-37.

Claridge, G., Beech, T. (1995). Fully and quasi-dimensional constructions of schizotypy. In: Raine, A., Lencz, T., Mednick, S. A., eds. *Schizotypal Personality Disorder*. Cambridge, UK: Cambridge University Press; 192–216.

Cohen, J. W. (1988). Statistical power analysis for the behavioral science (2nd edn). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cohen, A., Davis, T. (2009). Quality of life across the schizotypy spectrum: findings from a large nonclinical adult sample. *Comprehensive Psychiatry,* 50(*5*), 408-414.

David, D., Matu, S.-A. and David, O. A. (2013). New Directions in Virtual Reality-Based Therapy for Anxiety Disorders. *International Journal of Cognitive Therapy, 6*(2), 114-137.

Ettinger, U., Meyhöfer, I., Steffens, M., Wagner, M., Koutsouleris, N. (2014). Genetics, cognition, and neurobiology of schizotypal personality: a review of the overlap with schizophrenia. *Frontiers in Psychiatry,* 5(*18*), 1-16.

Fenigstein, A., & Vanable, P. A. (1992). Paranoia and self-consciousness. *Journal of personality and social psychology,* 62(*1*), 129.

Fisher, H. L., Appiah-Kusi, E. and Grant, C. (2012). Anxiety and negative self-schemas mediate the association between childhood maltreatment and paranoid. *Psychiatry Research*, 196(*2-3*), 323-324.

Fonseca-Pedrero, E., Paíno, M., Lemos-Giráldez S., García-Cueto E., Campillo-Álvarez, Á., Villazón-García, Ú., and Muñiz, J. (2008). Schizotypy assessment: State of the art and future prospect. *Internal Journal of Clinical and Health Psychology*, 8(*2*), 577-593.

Fonseca-Pedrero, E., Paíno, M., Lemos-Giráldez, S., Sierra-Baigrie, S., Muñiz, J. (2011). Measurement invariance of the Schizotypal Personality Questionnaire-Brief across gender and age. *Psychiatry Research,* 190, 309-315.

Freeman, D., Garety, P. A., Bebbington, P. E., Smith, B., Rollinson, R., Fowler, D., Kuipers, E., Ray, K. and Dunn, G. (2005). Psychological investigation of the structure of paranoia in a non-clinical population. *British Journal of Psychiatry,* 186, 427-435.

Freeman, D., Gittins, M., Pugh, K., Antley, A., Slater, M. and Dunn, G. (2008b). What makes one person paranoid and another person anxious? The differential prediction of social anxiety and persecutory ideation in an experimental situation. *Psychology Medicine,* 38, 1121-1132.

Freeman, D., Pugh, K., Antley, A., Slater, M., Bebbington, P., Gittins M., Dunn, G., Kuipers, E., Fowler, D. and Garety, P. (2008a). Virtual reality study of paranoid thinking in the general population. *The British Journal of Psychiatry,* 192, 258-263.

Freeman, D., Pugh, K., Green, C., Valmaggia, L., Dunn, G., & Garety, P. (2007). A measure of state persecutory ideation for experimental studies. *The Journal of nervous and mental disease*, 195(*9*), 781-784.

Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B. and Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological medicine,* 47, 2393–2400.

Freeman, D., Slater, M., Bebbington, P. E., Garety, P. A., Kuipers, E., Fowler, D., Met, A. Read, C. M., Jordan, J. and Vinayagamoorthy, V. (2003). Can Virtual Reality be Used to Investigate Persecutory Ideation? *The Journal of Nervous and Mental Disease,* 191(*8*), 509-514.

Fusar-Poli, P., Tantardini, M., De Simone, S., Ramella-Cravaro, V., Oliver, D., Kingdon, J., Kotlicka-Antczak, Valmaggia, L., Lee, J., Millan, M. J., Galderisi, S., Balottin, U., Ricca, V., McGuire, P. (2017). Deconstructing vulnerability for psychosis: Meta-analysis of environmental risk factors for psychosis in subjects at ultra high-risk. *European Psychiatry,* 40, 65-75.

Gerardi, M., Cukor, J., Difede, J., Rizzo, A. & Rothbaum, B. O. (2010). Virtual reality exposure therapy for post-traumatic stress disorder and other anxiety disorders. *Current psychiatry reports,* 12, 298–305.

Green, C. E. L., Freeman, D., Kuipers, E., Bebbington, P., Fowler, D., Dunn, G. and Garety, P. A. (2008). Measuring ideas of persecution and social reference: the Green et al. Paranoid Thought Scales (GPTS), 38, 101-111.

Green, M. J., Williams, L. M. (1999). Schizotypy and creativity as effects of reduced cognitive inhibition. *Personality and Individual Differences*, 27(*2*), 263-276.

Hall G. and Habbits, P. (1996). Shadowing on the basis of contextual information in individuals with schizotypal personality. *British Journal of Clinical Psychologist*, 35, 595-604.

Keith, S. J. and Matthews, S. M. (1991). The Diagnosis of Schizophrenia: A Review of Onset and Duration Issues. *Schizophrenia Bulletin,* 17(*1*), 51-67.

Kwapil, T. R. and Barrantes-Vidal, N. (2015). Schizotypy: Looking Back and Moving Forward. *Schizophrenia Bulletin,* 41(2), 366-373.

Kwapil, T. R., Barrantes-Vidal, N. and Silvia P. J. (2008). The Dimensional Structure of the Wisconsin Schizotypy Scales: Factor Identification and Construct Validity. *Schizophrenia Bulletin,* 34(*3*), 444-457.

Kwapil, T. R., Brown, L. H., Silvia, P. J., Myin-Germeys, I. and Barrantes-Vidal, N. (2012). The expression of positive and negative schizotypy in daily life: and experience sampling study. *Psychological Medicine,* 42, 2555-2566.

Kwapil, T. R., Gross, G. M., Silvia, P. J., & Barrantes-Vidal, N. (2013). Prediction of psychopathology and functional impairment by positive and negative schizotypy in the Chapmans' ten-year longitudinal study. *Journal of Abnormal Psychology*, 122(*3*), 807.

Martin, J. A., Penn, D. L. (2001). Brief report Social cognition and subclinical paranoid ideation. *British Journal of Clinical Psychology,* 40, 261-265.

Masillo, A., Day, F., Laing, J., Howes, O., Fusar-Poli, P., Byrne, M., Bhattacharyya, S., Fiori Nastro, P., Girardi, P., McGuire, P. K. and Valmaggia, L. (2012). Interpersonal sensitivity in the at-risk mental state for psychosis. *Psychological Medicine,* 42, 1835-1845.

Masillo, A., Valmaggia, L. R., Saba, R., Brandizzi, M., Lindau, J. F., Solfanelli, A., Curto, M., Narilli, F., Telesforo, L., Kotzalidis, G. D., Di Pietro, D., D'Alema, M., Girardi, P., Fiori, Nastro, P. (2016). Interpersonal sensitivity and functioning impairment in youth at ultra-high risk for psychosis. *European Child & Adolescent Psychiatry, 25*(*1*), 7–16

Mathijsen, F. P. (2015). Anomalous experiences and schizotypy: which come first? The Hermit Crab syndrome hypothesis. *Mental Health, Religion & Culture*, 1-11.

McDonnell, J., Stahl, D., Day, F., McGuire, P., Valmaggia, L. R. (2018). Interpersonal sensitivity in those at clinical high risk for psychosis mediates the association between childhood bullying victimisation and paranoid ideation: a virtual reality study. *Schizophrenia Research,* 192, 89-95.

Meehl, P. E. (1962). Schizotaxia, schizotypy, schizophrenia. *American psychologist*, *17*(12), 827.

Meehl, P. E. (1989). Schizotaxia revisited. *Archives Of General Psychiatry*, 46(*10*), 935-944.

Meisel, S. F., Garety, P. A., Stahl, D. and Valmaggia, L. (2018). Interpersonal processes in paranoia: a systematic review. *Psychology Medicine,* 48, 2299-2312.

Miller, T. J., McGlashan, T. H., Woods, S. W., Stein, K., Driesen, N., Corcoran, C. M., Hoffman, R., Davidson, L. (1999). Symptom assessment in schizophrenic prodromal states. *Psychiatric Quarterly*, 70*,* 273–287

Nelson, M., Seal, M., Pantelis, C., Phillips, L. (2013). Evidence of a dimensional relationship between schizotypy and schizophrenia: a systematic review. *Neuroscience and Biobehavioural Reviews,* 37(*3*), 317-327.

Nuevo, R., Chatterji, S., Verdes, E., Naidoo, N., Arango, C. and Ayuso-Mateos, J. L. (2012). The Continuum of Psychotic Symptoms in the General Population: A Cross-national Study. *Schizophrenia Bulletin,* 38(*3*), 475-485.

Otani, K., Suzuki, A., Matsumoto, Y., Shirata, T. (2018). Close relation of interpersonal sensitivity with negative core beliefs about the self, the central construct of cognitive vulnerability to depression. *Psychiatry Research,* 263, 162-165.

Perkins, D. O., Jeffries, C. D., Cornblatt, B. A., Woods, S. W., Addington, J., Bearden C. E., Cadenhead, K. S., Cannon, T. D., Heinssen, R., Mathalon, D. H., Seidman, L. J., Tsuang, M. T., Walker, E. F., McGlashan, T. H. (2015). Severity of Thought Disorder Predicts Psychosis in Persons at Clinical High-Risk. *Schizophrenia Research,* 169(*1-3*), 169-177.

Pot-Kolder, R. M. C. A., Geraets, C. N. W., Veling, W., van Beilen, M., Staring, A. B. P., Gijsman, H. J., Delespaul, P. A. E. G., van der Gaag M. (2018). Virtual-reality-based cognitive behavioural therapy versus waiting list control for paranoid ideation and aosical avoidance in patients with psychotic disorders: a single-blind randomised controlled trial. *Lancet Psychiatry,* 5, 217-26.

Powers, M., Emmelkamp, P. (2008) Virtual reality exposure therapy for anxiety disorders: a meta-analysis. *Journal of Anxiety Disorders,* 22, 561–569.

Premkumar, P., Onwumere, J., Betts, L., Kibowski, F., Kuipers, E. (2018). Schizotypal traits and their relation to rejection sensitivity in the general population: Their mediation by quality of life, agreeableness and neuroticism. *Psychiatry Research,* 267, 201-209.

Raballo, A., Larøi, F. (2011). Psychosis risk syndrome and DSM-5: time for a dimensional approach to at-risk mental states? *Clinical Schizophrenia and Related Psychoses,* 5, 155–158.

Rado, S. (1953). Dynamics and classification of disordered behavior. *American Journal of Psychiatry,* 110, 406-426.

Raine A. (1991). The SPQ: a scale for the assessment of schizotypal personality based on DSM-III-R criteria. *Schizophrenia Bulletin,* 17(*4*), 555–564.

Raine, A., Lencz, T., Mednick, S. A (1995). *Schizotypal Personality Disorder*. Cambridge, UK: Cambridge University Press; 192–216.

Raine, A., Reynolds, C., Lencz, T., Scerbo, A., Triphon, N., & Kim, D. (1994). Cognitive-perceptual, interpersonal, and disorganized features of schizotypal personality. *Schizophrenia Bulletin*, *20*(1), 191–201.

Reynolds, C. A., Raine, A., Mellingen, K., Venables, P. H. and Mednick, S. A. (2000). Three-Factor Model of Schizotypal Personality: Invariance Across Culture, Gender, Religious, Affiliation, Family Adversity, and Psychopathology. *Schizophrenia Bulletin,* 26(*3*), 603-618.

Riches, S., Bird, L., Chan, N., Garety, P., Rus-Calafell, M., Valmaggia, L. (2020). Subjective experience of paranoid ideation in a virtual reality social environment: A mixed methods cross-sectional study. *Clinical Psychology & Psychotherapy,* 1-9.

Riches, S., Garety, P., Rus-Calafell, M., Stahl, D., Evans, C., Sarras, N., Yeboah, K. and Valmaggia, L. (2019). Using Virtual Reality to Assess Associations Between Paranoid Ideation and Components of Social Performance: A Pilot Validation Study. *Cyberpsychology, Behavior, and Social Networking,* 22(*1*), 51-59.

Rus-Calafell, M., Garety, P., Sason, E., Craig, T. J. K., Valmaggia, L. M. (2017). Virtual Reality in the Assessment and Treatment of Psychosis: A Systematic Review of Its Utility, Acceptability and Effectiveness. *Psychological Medicine,* 1-30.

Salokangas, R. K. R., Dingemans, P., Heinimaa, M., Svirskis, T., Luutonen, S., Hietala, J., Ruhrmann, S., Juckel, G., von Reventlow, H. G., Linszen, D., Birchwood, M., Patterson, P., Schultze-Lutter, F., Klosterkötter, J. (2013). Prediction of psychosis in clinical high-risk patients by the Schizotypal Personality Questionnaire. Results of the EPOS project. *European Psychiatry,* 28, 469-475.

Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences,* 364, 3549–3557.

Valmaggia, L. R., Day, F., Garety, P., Freeman, D., Antley, A., Slater, M., Swapp, D., Myin-Germeys, I., McGuire, P. (2015). Social defeat predicts paranoid appraisals in people at high risk for psychosis. *Schizophrenia Research*, 168, 16-22.

Valmaggia, L. R., Day, F., Rus-Calafell, M. (2016a). Using virtual reality to investigate psychological processes and mechanisms associated with the onset and maintenance of psychosis: a systematic review. *Social Psychiatry and Psychiatry Epidemiology,* 51*,* 921–936

Valmaggia, L. R., Freeman, D., Green C., Garety, P., Swapp, D., Antley, A., Prescott, C., Fowler, D., Kuipers, E., Bebbington, P., Slater, M., Broome, W. and McGuire, P. (2007). Virtual reality and paranoid ideations in people with an "at-risk mental state" for psychosis. *British Journal of Psychiatry,* 191(*51*), 63-68.

Valmaggia, L. R., Latif, L., Kempton, M. J., Rus-Calafell, M. (2016b). Virtual reality in the psychological treatment for mental health problems: a systematic review of recent evidence. *Psychiatry Research,* 236,189–195

van Os, J., Hanssen, M., Bijl, R. V., Ravelli, A. (2000). Strauss (1969) revisited: a psychosis continuum in the general population? *Schizophrenia Research*, 45, 11-20.

van Rijn, S., Kroonenberg, P., Ziermans, T., and Swaab, H. (2015). The Dimensional Structure of the Schizotypal Personality Questionnaire Adapted for Children (SPQ-C-D): An Evaluation in the Dutch Population and a Comparison to Adult Populations. *Advance in Psychiatry,* 1-8.

Wilcox, J., Briones, D., Quadri, S., Tsuang, M. (2014). Prognostic implications of paranoia and thoughts disorder in new onset psychosis. *Comprehensive Psychiatry,* 55, 813-817.

Yung, A. R., Yuen, H. P., McGorry, P. D., Phillips, L. J., Kelly, D., Dell'Olio, M., Francey, S. M., Cosgrave, E. M., Killackey, E., Stanford, C., Godfrey, K., Buckby, J. (2005). Mapping the onset of psychosis: the Comprehensive

Assessment of At-Risk Mental States. *Australian and New Zealand Journal of Psychiatry,* 39, 964–971.

25. Appendix I Research Ethics Committee documents

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KING'S College LONDON

Fabio Massaro

10 July 2019

Dear Fabio,

Study Title: The relationship of interpersonal sensitivity with schizotypy and with state paranoid ideation in a sample of healthy individuals with low, moderate, and high positive schizotypy.

Study Reference:HR-18/19-11624

I am pleased to inform you that full approval for your project has been granted by the PNM Research Ethics Subcommittee .

For your information, ethical approval has been granted for 3 years from 10 July 2019. If you need approval beyond this point, you will need to apply for an extension at least two weeks before this. You will be required to explain the reasons for the extension. However, you will not need to submit a full re-application unless the protocol has changed.

Ethical approval is required to cover the data-collection phase of the study. This will be until the date specified in this letter. However, you do not need ethical approval to cover subsequent data analysis or publication of the results. For secondary data-analysis, ethical approval is applicable to the data that is sensitive or identifies participants.

Please ensure that you follow the guidelines for good research practice as laid out in UKRIO's Code of Practice for research: https://www.kcl.ac.uk/research/support/integrity-good-conduct/index.aspx

Please note you are required to adhere to all research data/records management and storage procedures agreed to as part of your application. This will be expected even after the completion of the study.

If you do not start the project within three months of this letter, please contact the Research Ethics Office.

Please note that you will be required to obtain approval to modify the study. This also encompasses extensions to periods of approval. Please refer to the URL below for further guidance about the process:

https://internal.kcl.ac.uk/innovation/research/ethics/applications/modifications.aspx

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact the Research Ethics Office:

(https://internal.kcl.ac.uk/innovation/research/ethics/contact.aspx)

We wish you every success with this work.

Yours sincerely,

Mr James Patterson
Senior Research Ethics Officer

For and on behalf of

Chair of the PNM Research Ethics Subcommittee

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KING'S College LONDON

30/07/2019

Fabio Massaro

Dear Fabio

KDPR Registration Reference: DPRF-18/19-9225
Project Title: The relationship of interpersonal sensitivity with schizotypy and with state paranoid ideation in a sample of healthy individuals with low, moderate, and high positive schizotypy.

Thank you for submitting the above Research Data Protection Registration Form. This letter acknowledges confirmation of your registration; your registration confirmation reference number is detailed above.

Be sure to keep a record your registration number. A copy of this letter will automatically be stored in your KDPR account, but you may wish to keep a separate copy in your own records.

Registration is valid for the data holding period you have indicated within the form.

Please note it is the responsibility of the researcher to ensure that any other permissions or approvals (i.e. Research Ethics, R&D, gatekeepers, etc.) relevant to their research are in place, prior to data collection.

Modifications

Should there be any changes to the conduct of your study or your study timelines which will impact on how you collect, manage or otherwise use your data, then you must submit a modification request in KDPR, indicating what has changed. Modification requests will be required in instances such as (this is not an exhaustive list):

- Change of storage repository
- Change to data retention period
- Change of data controller if that person should leave the College
- Change to the nature of the identifiers in the data you collect
- Change of anticipated start date of data collection

You will find the modification request form within the project you have created. You can access this by selected 'Create sub-form' in the left hand tiles on the screen and selecting 'Modification Request Form.'

Audit:

As part of the College's responsibilities under the General Data Protection Regulation, it must ensure that data is collected, managed and otherwise used as outlined within the submitted registration forms. As such the College is required to audit this process. You may therefore be selected for a random audit, to see how researchers are implementing this process. If audited, you will be expected to provide evidence that you are collecting, managing or otherwise using your data as outlined within the form.

If you have any questions regarding your registration please email rgo@kcl.ac.uk

We wish you every success with your project.

With best wishes

KCL Research Governance Office

Full Application Form

Filter Questions

1 Is your study considered research as defined in the guidance icon information? (●) Yes ( ) No

2 Does your study require external ethical review by either the Health Research Authority (which includes the NHS REC and Social Care REC) or the Ministry of Defence REC?

See guidance icon for further information on the HRA and MOD REC ethical review remit.

( ) Yes
(●) No

Data Collection

3 Select one category from the list below (categories are defined in the guidance icon).

My study involves:

(●) a) Only primary data collection involving human subjects.
( ) b) Only analysis of pre-existing human subject data which is not in the public domain and contains identifiable personal data (see guidance icon for definition)
( ) c) Both primary data collection involving human subjects and analysis of pre-existing human subject data which is not in the public domain and contains identifiable personal data (see guidance icon for definition)
( ) d) Data collection not involving any of the above but presenting sensitive issues
( ) e) None of the above

4 Select all that apply in order to determine the risk level of your application.

- ☐ a) Does the research involve participants who are particularly vulnerable or unable to give informed consent or in a dependent position?
- ☐ b) Will participants be asked to take part in the study without their consent or knowledge at the time or will deception of any sort be involved?
- ☐ c) Is there a risk that the research topic might lead to disclosures from the participant concerning their involvement in illegal activities or other activities that represent a threat to themselves or others?
- ☑ d) Could the study induce psychological stress or anxiety, or produce humiliation or cause harm or negative consequences beyond the risks encountered in a participant's usual everyday life?
- ☐ e) Is there a foreseeable likelihood that a participant's capacity to give fully informed consent may diminish throughout the course of the project? i.e. early stage dementia, brain injury etc.
- ☐ f) Does the study involve imaging techniques such as MRI scans or ultrasound?
- ☐ g) Does the study involve sources of non-ionising radiation (e.g. lasers)?
- ☐ h) Does the study involve physically invansive procedures, use of bodily materials, or DNA/RNA analysis? (including collection of human tissue)

You should only select the statement below if you have not selected any of the above risks. Your application will be invalid if you select the below statement in addition to any of the above risks.

- ☐ I have answered no to all questions in the risk checklist above and I believe that my research is low risk

Based on your answers to the above filter questions your research has been categorised as High Risk and upon submission will be subject to review at the next relevant Research Ethics Subcommittee meeting. You can now access an overview of the available sections of the application by selecting the navigate tile in the action panel on the left. Alternatively you can proceed through each section of the application by selecting the next tile.

Meeting dates and submission deadlines can be found here

Section A: General Information

A Applicant Details

Title	First Name	Surname
Mr	Fabio	Massaro

Department: King's College London, Institute of Psychiatry, Psychology & Neuroscience - Department of Psychology.

KCL Email: fabio.massaro@kcl.ac.uk

A2 Applicant Status

MPhil / PhD/ Specialist Doctorate

A7 Faculty/Institute/School

Please refer to the information icon if you are unsure of your Faculty/Institute/School.

Psychiatry, Psychology & Neuroscience

A8 Course/Qualification

Doctorate in Clinical Psychology/DClinPsy

A10 Supervisor Details

Title	First Name	Surname
Dr	Lucia	Valmaggia

Position: 1st supervisor - Reader in Clinical Psychology and Digital Mental Health

Department: Psychology

Email: lucia.valmaggia@kcl.ac.uk

A11 Do you have a medical supervisor?

- ○ Yes
- ◉ No

A13

Title	First Name	Surname
Dr	Elena	Antonova

Organisation: King's College London, Institute of Psychiatry, Psychology and Neuroscience,

Email: elena.antonova@kcl.ac.uk

What is the role of this investigator?

Second supervisor

Section B: Project Information

B1 Project Title
A working title that accurately reflect the aims of the project.

The relationship of interpersonal sensitivity with schizotypy and with state paranoid ideation in a sample of healthy individuals with low, moderate, and high positive schizotypy.

B2 Anticipated start date for the collection of data: 23/06/2019

B3 Expected completion date of the project: 31/03/2020

B4 Is this a funded project?

- (•) Yes
- ( ) No

B4a How is the project being funded?

KCL funded

B5 What are the aims and objectives of the project?

Provide the academic/scientific justification of the project as well as detailing and explaining the principal research question, objectives and hypotheses to be tested.
Please Note: Applications to the BDM and PNM RESC should include a full list of references/citations to back up the academic/scientific justification of the project.

Aims and objectives

This project has two aims:
• The first is to investigate the relationship of interpersonal sensitivity with schizotypy and with paranoid ideation (state and trait) in a sample of healthy individuals with low, moderate, and high positive schizotypy.
• The second aim is to establish the test-retest reliability of VR Pub paradigm in inducing state paranoid ideation.

Scientific justification

Schizotypy: a multidimensional construct
Despite some disagreement regarding the factorial composition of schizotypy (Stefanis et al., 2004), the general consensus of its underlying components is that schizotypy is composed of three factors, which broadly reflect symptom dimensions of schizophrenia (Fonseca-Pedrero et al., 2011):
• a positive dimension – characterised by hallucinations, ideas or reference, magical thinking or paranoid ideation;
• a negative dimension – which refers to blunted affect, social anxiety and isolation;
• and a disorganised dimension – which compromises odd behaviours and speech.
Literature reports that the positive and negative schizotypy dimensions are differently related to psychopathology, social functioning and personality, with positive schizotypy being distinctively linked to psychotic-like experiences, and negative schizotypy being

associated more with schizophrenia-spectrum disorders (Fonseca-Pedrero et al., 2011; Kwapil et al., 2013; Debbané et al., 2014).

Schizotypy and interpersonal sensitivity
Originally defined by Boyce & Parker (1989) as “undue and excessive awareness of and sensitivity to, the behaviour and feelings of others” (p. 342), interpersonal sensitivity has been associated with the prodromal phase of psychosis (Masillo, et al., 2012) and described as a vulnerability factor for the development of depression (Boyce et al., 1996). A breath of research has documented interpersonal sensitivity deficits, such as difficulties in “reading others” and in “understanding nonverbal social cues” in nonpsychotic schizotypes (Miller et al., 2012; Toomey et al., 2002). Similar findings were also illustrated by McCabe et al. (1999) showing that the Interpersonal Sensitivity Measure (IPSM) was associated with low social and academic self-esteem, depressive symptoms and poorer academic performance in a healthy population of college students.

Virtual Reality in mental health
VR is a multi-sensory interactive computer-generated world that allows subjects to experience the sensation of actually being in a real-life sized environment by replacing the real-world sensory perceptions with digitally created ones. Virtual Reality (VR) is progressively becoming an important part of the assessment, understanding and treatment of mental health problems (Valmaggia et al 2016b; Freeman, et al. 2017). VR has been demonstrated to be the ideal methodology to assess state paranoia VR (Freeman et al 2005; Valmaggia et al 2016a).

Study rationale
While previous research has investigated the relationship between Interpersonal sensitivity and psychosis, no research to date has explored the relationship of interpersonal sensitivity with schizotypy and with paranoid ideation (state and trait) in a sample of healthy individuals with low, moderate, and high positive schizotypy.

Research questions:
1. Is there a correlation between schizotypy, interpersonal sensitivity and paranoid ideation (state and trait) in a non-clinical sample?
2. Do baseline higher levels of schizotypy predict real-time paranoid ideation in VR environment?
3. Do baseline higher levels of Interpersonal sensitivity predict real-time paranoid ideation in VR environment?
4. Does exposure to the VR test-retest elicit habituation or sensitisation effects?

Hypotheses:
1. Higher levels of schizotypy will be associated with higher interpersonal sensitivity.
2. Exposure to the VR environment will elicit state paranoid ideation
3. Higher levels of schizotypy at baseline will be associated with increased state paranoid ideation in VR.
4. Higher levels of Interpersonal sensitivity will be associated with increased state paranoid ideation in VR.
5. VR test-retest reliability will be investigated with an open-ended approach, as either habituation or sensitisation effects could occur. As this study is an estimation task it will not be hypothesis driven.

References

• Boyce, P., Mason, C. (1996). An overview of depression-prone personality traits and the role of interpersonal sensitivity. Australian & New Zealand Journal of Psychiatry, 30, 90–103
• Boyce, P., Parker, G. (1989). Development of a scale to measure interpersonal sensitivity. Australian and New Zealand Journal of Psychiatry, 23, 341–351.
• Debbané, M., Eliez, S., Badoud, D., Conus, P., Flückiger, R., & Schultze-Lutter, F. (2014). Developing psychosis and its risk states through the lens of schizotypy. Schizophrenia bulletin, 41, S396-S407.
• Fonseca-Pedrero, E., Mercedes, P., Lemos-Giraldez, S., Sierra-Baigrie, S., Muñiz (2011). Measurement invariance of the Schizotypal Personality Questionnaire-Brief across gender and age. Pychiatry Research, 190(2-3), 309-315.
• Freeman, D., Garety, P. A., Bebbington, P., Slater, M., Kuipers, E., Fowler, D., Green, C., Jordan, J., Ray, K., Dunn, G. (2005). The psychology of persecutory ideation II: a virtual reality experimental study. The Journal of Nervous and Mental Disease, 193(5), 309–315.
• Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B. and Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. Psychological medicine, 47, 2393–2400.
• Kwapil, T. R., Gross, G. M., Silvia, P. J., & Barrantes-Vidal, N. (2013). Prediction of psychopathology and functional impairment by positive and negative schizotypy in the Chapmans' ten-year longitudinal study. Journal of Abnormal Psychology, 122(3), 807.
• Masillo, A., Day, F., Laing, J., Howes, O., Fusar-Poli, P., Byrne, M., Bhattacharyya, S., Fiori Nastro, P., Girardi, P., McGuire, P. K. and Valmaggia, L. (2012). Interpersonal sensitivity in the at-risk mental state for psychosis. Psychological Medicine, 42, 1835-1845.
• McCabe, R. E., Blankstein, K. R., & Mills, J. S. (1999). Interpersonal sensitivity and social problem-solving: Relations with academic and social self-esteem, depressive symptoms, and academic performance. Cognitive Therapy and Research, 23, 587–604.
• Miller, A. B. and Lenzeweger, M. F. (2012). Schizotypy, Social Cognition, and Interpersonal Sensitivity. Personality Disorders: Theory, Research, and Treatment, 3(4), 379-392.
• Stefanis, N. C., Van Os, J., Avramopoulos, D., Smyrnis, N., Evdokimidis, I., Hantoumi, I. (2004). Variation in catechol-O-methyltransferase val58 met genotype associated with schizotypy but not cognition: a population study in 543 young men. Biol. Psychiatry, 56(7), 510–515.
• Toomey, R., Schuldberg, D., Corrigan, P., & Green, M. F. (2002). Nonverbal social perception and symptomatology in schizophrenia. Schizophrenia Research, 53, 83–91.
• Valmaggia, L. R., Day, F., Rus-Calafell, M. (2016a). Using virtual reality to investigate psychological processes and mechanisms associated with the onset and maintenance of psychosis: a systematic review. Social Psychiatry and Psychiatry Epidemiology, 51, 921–936
• Valmaggia, L. R., Latif, L., Kempton, M. J., Rus-Calafell, M. (2016b). Virtual reality in the psychological treatment for mental health problems: a systematic review of recent evidence. Psychiatry Research, 236,189–195

B6 Where will the research be conducted? i.e in a facility within the college, in a private organisation, in a public place etc

Research will be conducted in King's College London, Institute of Psychiatry, Psychology & Neuroscience university buildings.

B7 If outside of the UK, please state the country/countries in which data collection is expected to occur.

N/A

B8 Selection of methodology from list: (select each that applies)

- [x] Questionnaires
- [x] Semi-structured interviews
- [ ] Unstructured Interviews
- [ ] Focus Groups
- [ ] Observation
- [ ] Clinical Procedures or Interventions
- [ ] Non-clinical Procedures or Interventions
- [ ] Randomised Controlled Trial
- [ ] Oral history
- [ ] Analysis of pre-existing data from human participants
- [ ] Audio/video recording or photography in a public place
- [x] Audio/video recording or photography in a private place
- [ ] Administration of food substances
- [x] Behavioural/Cognitive Testing
- [ ] Other

If you are using any standardised methods for any of the above selected methodologies, please provide an overview of any standardised documentation to be used. Please provide full names and references where appropriate.

Please note you are not required to submit any standardised forms as supporting documents.

Participants using virtual reality equipment and entering a virtual environment.

The questionnaires used will be the following:
• The Schizotypal Personality Questionnaire (SPQ; Raine, 1991).
• The Interpersonal Sensitivity Scale (IPSM; Boyce & Parker, 1989). It is a 36-item scale designed to assess interpersonal sensitivity.
• The Paranoia Scale (Fenigstein and Vanable, 1992), designed to assess trait paranoia in the general population. This 20-item Likert scale has good test-retest reliability.
• State Social Paranoia Scale (SSPS) (Freeman et al., 2007) will be used to assess state paranoia elicited by the Virtual Reality experience.
• Visual Analogue Scales (VAS) rating affect (stressed/anxious/happy) and state paranoia before the VR experiment. Participants will be asked to mark a standard ten-centimetre visual analogue scale from 0 (e.g. not at all anxious) to 10 (e.g. extremely anxious).
• The Post VR Semi-Structured Interview (Freeman et al, 2003) This is a ten-minute semi-structured interview conducted to assess the spontaneous impressions participants made of the environment and the virtual characters. The interviews are tape recorded and then rated (blind to responses on the questionnaires) for persecutory content on a 6-point scale (0=none to 5=marked).

References:
• Raine, A. (1991). The SPQ: A Scale for the Assessment of Schizotypal Personality Based on DSM-III-R Criteria. Schizophrenia Bulletin, 17(4), 555–564.
• Boyce, P., Parker, G. (1989). Development of a scale to measure interpersonal sensitivity. Australian and New Zealand Journal of Psychiatry, 23, 341–351.
• Fenigstein, A., & Vanable, P. A. (1992). Paranoia and self-consciousness. Journal of personality and social psychology, 62(1), 129.
• Freeman, D., Pugh, K., Green, C., Valmaggia, L., Dunn, G., & Garety, P. (2007). A measure of state persecutory ideation for experimental studies. The Journal of nervous and mental disease, 195(9), 781-784.
• Freeman, D., Slater, M., Bebbington, P. E., et al (2003). Can virtual reality be used to investigate persecutory ideation? Journal of Nervous and Mental Disease, 191, 509-514.

B9 Provide an explanation in lay language outlining each methodology of the study, as identified in question B8.

Overview

The study will be conducted in two stages.

Stage 1: Online Survey
The first part of the study will involve a cross-sectional investigation of a large general population sample to investigate schizotypal personality traits. Healthy individuals will be asked to complete The Schizotypal Personality Questionnaire (SPQ; Raine, 1991) online.

Stage 2: Virtual Reality
In the second part of the study, participants who scored high, moderate or low on The Schizotypal Personality Questionnaire (SPQ; Raine, 1991) will be invited to participate to a VR study. A new VR environment (‘a social situation’) will be piloted to ensure participants are comfortable with the equipment and experience; and understand and are able to complete the tasks.

Participants

Stage 1 will involve completing one online questionnaire. Based on the Kemp, et al. 2018 study, which used similar procedure, we will recruit a minimum of 350 participants for the online questionnaire study to ensure a representative spread of schizotypy scores.

In Stage 2, 20 individuals with high positive schizotypy (+ 1 SD above the norm) on the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), 20 individuals with low positive schizotypy (-1 SD below the norm), and 20 individuals with moderate schizotypy (whose scores are between -1SD and +1SD), will be invited to take part in the VR pilot study. A ‘reserve list’ of the next 15 individuals for each category (low, moderate and high schizotypy) will be kept to in case any of the invited participants will be unavailable.

The procedure will be conducted using the following steps:

Stage 1
Recruitment via social media
Online Survey

Stage 2
Recruitment for the second part of the study will be based on baseline scores

Pre VR measures
VR exposure
Post VR measures

Measures

Stage 1 (Online Survey)
Socio-demographic information: including age, gender, employment, highest academic achievement, marital status, and ethnicity.

The Schizotypal Personality Questionnaire (SPQ; Raine, 1991). A 72-item self-report scale modelled on DMS-III-R criteria for schizotypal personality disorder and containing sub-scales for all nine schizotypal traits. The SPQ is used in screening for schizotypal personality disorder in the general population and also in researching the correlates of individual schizotypal traits.

Stage 2 (VR Pilot Study)
Stage 2 will be conducted across two different time points (t1 and t2) with 40 days apart. After 40 days from t1 participants will be re-invited to take part in the exact same study, held at the same location for the same duration. Participant will be paid £10 for each appointments (maximum of 2 appointments = £20).

Pre VR measures (t1):

• Interpersonal social distress will be measured by administering the Interpersonal Sensitivity Scale (IPSM, Boyce & Parker, 1989), which consists of 36 items rated on a four-point scale.
• The Paranoia Scale (Fenigstein and Vanable, 1992), designed to assess paranoia in the general population, will be used to assess changes in paranoia following the intervention. This 20-item Likert scale has good test-retest reliability.
• Visual Analogue Scales (VAS), designed to assess how being in the social VR environment may have affected mood, participants will complete visual analogue scales (VAS) before and after the VR experiment, rating affect (stressed/anxious/happy) and state paranoia. Participants will be asked to mark a standard ten-centimetre visual analogue scale from 0 (e.g. not at all anxious) to 10 (e.g. extremely anxious).

Post-VR measures (t1):

• Visual Analogue Scales (VAS) as above. Post VR only, four VAS will be added; how socially anxious you felt with the other people in the social situation? How much did you want to avoid social interaction with others during the social situation? How did you think the other people were thinking about during the social situation? (negatively-positively). Two final VAS will explore the experience of the VR social situation, assessing level of presence or immersion and enjoyment will be added.
• The State Social Paranoia Scale (SSPS). This is a 20 item self-report questionnaire examining paranoia, specifically paranoid ideation about VR avatars (Freeman et al, 2007). Each of the 20 items is rated on a five point scale from 1= 'do not agree' to 5= 'totally agree', with higher scores indicating higher endorsement. In addition to examining persecution (10 items, range 10-50), neutral (5 items, range 5-25) and positive (5 items, range 5-25) ideation about the avatars is explored.
• The Post VR Semi-Structured Interview (Freeman et al, 2003). This is a ten-minute semi-structured interview conducted to assess the spontaneous impressions participants made of the environment and the virtual characters. The interviews are tape recorded and then rated (blind to responses on the questionnaires) for persecutory content on a 6-point scale (0=none to 5=marked). The interview will be modified to include social distress, social avoidance and fear of negative evaluation during the VR experience.

After 40 days

Pre VR measures (t2):

• Visual Analogue Scales (VAS) – as in pre VR measures (t1)

Post-VR measures (t2):
• Visual Analogue Scales (VAS) - as in post VR measures (t1).
• The State Social Paranoia Scale (SSPS) – as above
• The Post VR Semi-Structured Interview (Freeman et al, 2003) – as above

The Online Surveys platform will be used to administer all the questionnaires.

Virtual Reality Scenario
The VR that participants will be asked to enter will last a few minutes and will be identical for both time points. It will be a 'party' with other 'people' present (i.e. computer-controlled avatars). Participants will see the images in 3D and hear sound through headphones in their headset. Participants will experience some group conversations in the background and experience some neutral interactions between the people at the party with some ambiguous stimuli.

References:

• Raine, A. (1991). The SPQ: A Scale for the Assessment of Schizotypal Personality Based on DSM-III-R Criteria. Schizophrenia Bulletin, 17(4), 555–564.
• Boyce, P., Parker, G. (1989). Development of a scale to measure interpersonal sensitivity. Australian and New Zealand Journal of Psychiatry, 23, 341–351.
• Fenigstein, A., & Vanable, P. A. (1992). Paranoia and self-consciousness. Journal of personality and social psychology, 62(1), 129.
• Freeman, D., Pugh, K., Green, C., Valmaggia, L., Dunn, G., & Garety, P. (2007). A measure of state persecutory ideation for experimental studies. The Journal of nervous and mental disease, 195(9), 781-784.
• Freeman, D., Slater, M., Bebbington, P. E., et al (2003). Can virtual reality be used to investigate persecutory ideation? Journal of Nervous and Mental Disease, 191, 509-514.
• Kemp, K. C., Gross, G. M., Barrantes-Vidal, N., Kwapil, T. R. (2018). Association of positive, negative, and disorganized schizotypy dimensions with affective symptoms and experiences. Psychiatry Research, 2018, 1143-1149.

If the summary of your methodology would be supported by a flowchart please attach this here (an editable flowchart can be found via the link in the guidance icon)

B10 I confirm that the researcher who will be administering all tests and/or procedures is competent in the methods.

- (•) Yes
- ( ) No

Section C(I): Participants

C1 Detail your projected number of participants and provide justification for this sample size.
Please note: For projects involving mixed methods and/or multiple participant groups, you should provide an estimate of the number of participants taking part in each method.

Based on the Kemp et al 2018 study, which used similar methodology, we will recruit a minimum of 350 participants for the online questionnaire study to ensure a representative spread of schizotypy scores. We aim to recruit a subsample of 60 participants (20 with high schizotypy, 20 with moderate and 20 with low schizotypy) for stage 2 of the study.

References:
• Kemp, K. C., Gross, G. M., Barrantes-Vidal, N., Kwapil, T. R. (2018). Association of positive, negative, and disorganized schizotypy dimensions with affective symptoms and experiences. Psychiatry Research, 2018, 1143-1149.

C2a What are the Inclusion Criteria? Where appropriate explain how you will screen your participants. (the selection criteria should be clearly defined for multiple participant groups)

Participants will be healthy working age adults (aged 18-65) who are fluent speakers of English; and willing to be invited to attend the Institute of Psychiatry, Psychology & Neuroscience site at a time of their convenience between June and March 2020 should they be selected for the VR study. Participants will be screened by the online survey.

C2b What are the Exclusion Criteria? Where appropriate explain how you will screen your participants. (the selection criteria should be clearly defined for multiple participant groups)

People who have received treatment for mental health problems; people with a current or previous diagnosis of a mental health condition, neurological disorders, a learning disability, history of current substance misuses or epilepsy. Participants will be screened by the online survey.

C3 What are the upper and lower age limits? Provide justification for these where appropriate.

18-65. We use these age limits because we be will be only recruiting individuals from a working age adult population.

C4 How will potential participants be identified and approached?
Please note: If different recruitment methods will be used for participant groups, each group should be separately addressed.

Participants will be recruited online using regular bulletins though social media and online (e.g. Twitter, Facebook, LinkedIn, website) and through posters. These bulletins from social media will link to an online survey (using the online program Online Surveys).

C5 Do you have a current or prior relationship with any potential participants? (This includes professional and/or personal relationships)

- ○ Yes, I do have a current or prior relationships with potential participants.
- ◉ No, I do not have any current or prior relationships with potential participants.

C6 If using a gatekeeper to access participants, will the gatekeeper be in a position of influence or authority over the participants?

- ○ Yes, the gatekeeper is in a position of influence or authority over participants
- ○ No, the gatekeeper will not be in a position of influence or authority over participants
- ◉ N/A

C7 Please specify any incentives being offered and a justification for their use.

Stage 1 (Online survey)
Participants will complete a number of online questionnaires on their thoughts and feelings, especially about social situations. They will be entered into a draw for four vouchers of £25 and will be informed that they may be invited for the VR study.

Stage 2 (VR)
The subsample of 60 participants will be paid £10 for each attended appointment (maximum 2 appointments = £20) to compensate for approximately an hour of their time for each time point (t1 and t2). Each appointment will consist of: approximately 5 minutes in the VR, further questionnaires (the PreVR questionnaire and the PostVR questionnaires), briefing and debriefing.

Informed Consent

C8 Will informed consent be sought from all participants? (•) Yes ( ) No

C8a How will informed consent be sought? Who will take consent and how will it be recorded?

Note: Justification must be provided for not gaining written consent

Informed consent will be taken online at Stage 1 and signed on paper with a researcher present at Stage 2.

C9 If any participants are under 16 will you seek additional consent from parents or carers? ( ) Yes ( ) No (•) N/A

C10 How long will participants be given to decide if they wish to participate?
Please provide justification if participants will be given less than 24 hours

At stage 1, participants can take as long as they need to decide if they wish to do the online survey and do not have to notify us if they decide not to do it. As stage 2, participants will be given 2 weeks to decide if they wish to do the VR.

C11 Detail the process by which participants may withdraw from the research both during the research and after it has been completed. A final withdrawal date should also be provided, after which participants may no longer withdraw their data from the study.

Participants are free to withdraw from this study at any time, without giving a reason. If after taking part they decide that they would no longer like their data to be used, they are entitled to ask for their data to be removed from the project, up until the time the results of the study are written up for publication (December 2019).

Section D: High Risk Research

D1d Risk Identified: The study could induce psychological stress or anxiety, or produce humiliation or cause harm or negative consequences beyond the risks encountered in normal life? Please fully explain how the risk will be mitigated.

The study could induce mild psychological stress or anxiety. Survey participants will be offered the number for the Samaritans or advised to contact their GP or their local IAPT service if the survey has raised any difficult feelings for them. VR participants will be offered a debrief with a member of the research team after the VR. If they disclose any ongoing difficult feelings they will be offered the number for the Samaritans or advised to contact their GP or their local IAPT service.

D2 What are the potential risks and burdens to the participant?

When people use virtual reality systems, some people sometimes experience some degree of nausea. This will be explained clearly in the Stage 2 information sheet that participants will receive when they are invited to the virtual reality appointment. If at any time participants wish to stop taking part in the study due to this or any other reason, they will be told that they can just say so and we will stop immediately. There has been some research that suggests that people using head-mounted displays might experience some disturbances in vision afterwards. No long term studies are known to us, but the studies which have been carried out do testing after about 30 minutes, and find the effect is still sometimes there. It will therefore be advised in the Stage 2 Information Sheet that participants do not drive a car, motorcycle, or use any piece of complicated machinery in the four hours immediately following being in virtual reality. There have been various reported side effects of using virtual reality equipment, such as 'flashbacks'. There is a possibility that an epileptic episode may be generated by the virtual reality equipment. This, for example, has been reported for computer video games. If participants have a history of epilepsy we will ask them not to take part in the study. This will be clearly stated on the Stage 1 Information Sheet and Consent Form.

D3 What are the potential benefits to the participant?

Participants will have the opportunity to contribute to this research and play a key role in the development of the approach. Results of the study will inform the future development of a novel and effective assessment and treatment approach to help people with serious mental health problems facing difficulties with social situations.

Stage 1 participants will be entered into a draw for four vouchers of £25 and will be informed that they may be invited for the VR study. At Stage 2 the subsample of 60 participants will be paid £10 for each attended appointment (max 2 appointments = total £20) in order to compensate for approximately an hour of their time for both t1 and t2 appointments.

D4 If you have guaranteed participant anonymity in the final report, confirm how this will be ensured.

Responses will be confidential and anonymous. All data is stored in a password protected electronic format. The results of this study will be used for academic publications and presentations but all data will be anonymised. Participants will be identified only with a number. Their contact details will be stored separately.

Section E(I): General Data Protection Regulation Requirements

E1 Does the project involve the collection and/or use of personally identifiable information?

Personally identifiable information is data that can be used to identify an individual, either directly or indirectly. This may include names, job titles, photos, videos, email addresses, usernames, IP addresses, DNA or one or more factors specific to the physical, genetic, mental, economic, cultural, or social identity of that person. See guidance icon for examples of personal data.

Please indicate which of the following applies:

- ○ a) The project involves the collection and/or use of personally identifiable information
- ◉ b) Personally identifiable information will only be obtained in order to contact potential participants. No further identifying information will be collected as part of the study.
- ○ c) No personally identifiable information will be collected and/or used for this project

E1b Please indicate which of the following applies:

- (●) The personal data used for recruitment purposes will not be linked to the anonymous data collected from participants and will not be held for any longer than is necessary for the purposes of recruitment.
- ( ) The identifiable information used for recruitment purposes will be linked to the data collected from the corresponding participant/s.

(●) I confirm that I understand that it is the responsibility of the researcher to ensure that all research data is appropriately handled and stored during and after the project in compliance with College guidelines:

KCL Research Data Management Guidelines

Section E(II) Data Handling, Protection and Storage

E5 Where will research data be stored during and after the study is completed?

All data will be stored in a password protected electronic format on KCL computers.

E7 How long will research data be stored for after the project is completed?

Guidance on data retention periods can be found in the King's Data Retention Schedule

Anonymised research data will be kept for a minimum of 15 years in line with KCL regulation.

E4 Research Dissemination: How will results be disseminated?

- ☑ Internal report (thesis)
- ☑ Journals
- ☑ Conference
- ☑ Other

If other, please specify:

Lab website

E10a Will the anonymous data set shared with any third parties and/or be archived for further use? ( ) Yes (●) No

Section H: Insurance, Risks and Ethical Issues

H1 Does the project involve any of the Risk Assessment criteria outlined in the information icon guidance? ○ Yes ◉ No

H2 I confirm that I have read the exclusion criteria for the College's Clinical Trials and Research Projects Involving Human Subjects Insurance Policy, detailed in the guidance icon, and that:

◉ a) This project meets the inclusion criteria of the policy
○ b) This project falls under the exclusion criteria and I have gained approval from the Finance Department, as instructed in the guidance icon
○ c) This project falls under the exclusion criteria but approval has not been granted by the Finance Department

H3 I confirm that my travel insurance arrangements are as follows:

○ a) I will secure College travel insurance (see guidance icon for further details)
○ b) I will secure personal travel insurance
◉ c) I do not require travel insurance as I will conduct the research in my country of legal residence
○ d) I will not secure travel insurance

H4 I confirm that if Disclosure & Barring Service clearance is required for my study, this will be obtained prior to the commencement of data collection. ○ Yes ○ No ◉ N/A

H5 I confirm that the No Fault Compensation Scheme will be offered to all UK based participants. ◉ Yes ○ No ○ N/A

H6 Give the details of any other review body approvals or permissions obtained (including gatekeepers, other Ethics Committees, peer review, R&D permission).

Approval granted by the Clinical Psychology Department at the Institute of Psychiatry, Psychology & Neuroscience.

H7 Give details of any other ethical issues which have not been addressed elsewhere in the application and explain how you will mitigate these risks.

N/A

Section I: Supporting Documents

I1 Participant Information Sheet

Type	Document Name	File Name	Version Date	Version	Size
Participant Information Sheet	Participant Information sheet - STAGE 2	Participant Information sheet - STAGE 2.docx	24/05/2019	Version 1	52.6 KB
Participant Information Sheet	ONLINE SURVEY - STAGE 1 - Participant Information sheet	ONLINE SURVEY - STAGE 1 - Participant Information sheet.docx	24/05/2019	Version 1	51.3 KB

Consent form (if applicable)

I2 Consent form

Type	Document Name	File Name	Version Date	Version	Size
Consent Form	Consent Form - STAGE 2	Consent Form - STAGE 2.docx	24/05/2019	Version 1	62.6 KB
Consent Form	ONLINE SURVEY - STAGE 1 Consent form	ONLINE SURVEY - STAGE 1 Consent form.pdf	24/05/2019	Version 1	47.3 KB

Questionnaires/Surveys (if applicable)

I4 Questionnaires/Surveys

Type	Document Name	File Name	Version Date	Version	Size
Questionnaires	List of questionnaires and references	List of questionnaires and references .docx	24/05/2019	Version 1	14.8 KB

Indicative questions, topic guides etc (if applicable)

I5 Indicative questions, topic guides etc

Evidence of any other approvals or permissions (includes gatekeeper, R&D, other ethical approvals) (if applicable)

I6 Evidence of any other approvals or permissions (includes gatekeeper, R&D, other ethical approvals)

Approach letters to gatekeeper organisations (if applicable)

I7 Approach letters to gatekeeper organisations

Advertisement document (email, poster, flyer etc) (if applicable)

I8 Advertisement document (email, poster, flyer etc)

Type	Document Name	File Name	Version Date	Version	Size
Advertisement Document	Virtual reality leaflet	Virtual reality leaflet.docx	24/05/2019	Version 1	420.1 KB
Advertisement Document	Sample online bulletin text	Sample online bulletin text.docx	24/05/2019	Version 1	15.1 KB

Cover Letter (for amendments and modifications) (if applicable)

I9 Cover Letter (for amendments and modifications)

Other (if applicable)

I10 Other

Type	Document Name	File Name	Version Date	Version	Size
Other	Confirmation form - part 2	Confirmation form - part 2.docx	24/05/2019	Version 1	46.6 KB
Other	Confirmation form - part 1	Confirmation form - part 1.docx	24/05/2019	Version 1	46.6 KB

Researcher/Applicant

J1 Researcher/Applicant Signature

I undertake to abide by accepted ethical principles and appropriate code(s) of practice in carrying out this study. The information supplied above is to the best of my knowledge accurate. I have read the Application Guidelines and clearly understand my obligations and the rights of participants, particularly as regards obtaining valid consent. I understand that I must not commence research with human participants until I have received full approval from the ethics committee.

Please note that in order to authorise your application you must sign off using your KCL email address i.e. joe.bloggs@kcl.ac.uk and your KCL password.

Supervisor authorisation for student projects (including PhD)

J2 Supervisor Signature

I confirm that I have read this application and will be acting as the student researcher's supervisor for this project. The proposal is viable and the student has appropriate skills to undertake the research. Participant selection and recruitment procedures, including the Information Sheet(s) to be provided and the manner of obtaining informed consent, are appropriate and the ethical issues arising from the project have been addressed in the application. I understand that research with human participants must not commence without full approval from the ethics committee. I understand that by authorising this application I am confirming that the student has read an appropriate professional code of ethical practice and completed a risk assessment form where appropriate.

Note to applicant: In order for your named supervisor to authorise your application they must have an activated REMAS account. If they have not yet activated their account prior to you requesting their authorisation, they will need to do this by logging into the system.

Supervisor Authorisation For Student Projects (Including PhD)

Supervisors should authorise by entering their full KCL email i.e. joe.bloggs@kcl.ac.uk and KCL password

26. Appendix II Recruitment tools

Sample online bulletin text – long

"VIRTUAL REALITY AND SOCIAL SITUATIONS STUDY"

This is a study in two stages taking place at the Institute of Psychiatry, Psychology & Neuroscience, King's College London.

Stage 1: Online Survey
An online survey of working age adults is being carried out to better understand the thoughts and feelings that people experience to social situations. It takes approximately 20-25 minutes and can be completed on any computer, tablet or smartphone. ('Tableless mode' may be preferable for smaller devices). Everyone who completes the survey will be entered into a prize draw to win one of four £25 Amazon vouchers. The survey data will then be analysed to improve our understanding of the link between certain personality traits and how people think and feel about social situations.

Stage 2: Virtual Reality
A selection of those who complete the online survey will be invited to take part in a virtual reality study at the Institute of Psychiatry, Psychology & Neuroscience, King's College London (near Denmark Hill station). This aims to understand how people respond when entering a social environment in virtual reality.

The results of the study will inform the future development of a novel and effective assessment and treatment approaches to help people with serious mental health problems facing difficulties with social situations.

Click here to enter the online survey https://kings.onlinesurveys.ac.uk/virtual-reality-and-social-situations-copy

Sample online bulletin text – brief

"Recruiting participants for new #VirtualReality study @Kingspsychol @KingsIoPPN @KingDClinPsy in #London. Fill in survey to enter https://kings.onlinesurveys.ac.uk/virtual-reality-and-social-situations-copy"

An example forum for a brief online bulletin would be Twitter.

Want to take part in a

VIRTUAL REALITY

research study?

We are looking for study participants
at King's College London
Enter the study here

https://bit.ly/2Yyker3

Find the study on Twitter @fabimassaro

Want to take part in a

VIRTUAL REALITY

research study?

We are looking for study participants
at King's College London

Enter the study here

Find the study on Twitter @fabimassaro

VIRTUAL REALITY STUDY https://bit.ly/2Yyker3

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27. Appendix III Online survey output, information sheet and consent form

Virtual Reality and social situations

Page 1: INFORMATION SHEET FOR PARTICIPANTS

Ethical Clearance Reference Number: HR-18/19-11624

Title of study: "Virtual Reality and social situations"

Invitation Paragraph

We would like to invite you to participate in this research project which forms part of a doctoral degree at the Institute of Psychiatry, Psychology and Neuroscience, King's College London. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve.

Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

What is the purpose of the study?

We would like to get a better understanding of the relationship between aspects of personality and social situations. This study is composed of two stages.

Stage 1: Online Survey

An online survey of working age adults is being carried out to understand the responses to social situations. It takes approximately 10-15 minutes and can be completed on any computer, tablet or smartphone. ('Tableless mode' may be preferable for smaller devices). Everyone who completes the survey will be entered into a prize draw to win one of four £25 Amazon vouchers. The survey data will then be analysed to improve our understanding of the link between certain personality traits and how people think and feel about social situations.

Stage 2: Virtual Reality

A selection of those who complete the online survey will be invited to take part in a virtual

reality study at the Institute of Psychiatry, Psychology & Neuroscience, King's College London (near Denmark Hill station). This aims to understand how people respond when entering a social environment in virtual reality.

Why have I been invited to take part?

We are looking for participants aged between 18 and 65 years who have no history or current diagnosis of a serious mental health illness (e.g., psychosis or bipolar disorder), a neurological disorder, a learning disability or substance abuse. You can participate if you are fluent in English, have normal hearing and do not suffer from photosensitive epilepsy.

What will happen if I take part?

If you decide to participate, we will first ask you to complete an online survey at a place and time convenient to you (you will be provided with a link to the survey). The completion of the online survey will serve as the consent to this part of the study.

- The online survey will contain one questionnaire that will assess personality traits, with questions about things such as, what kind of experiences you have in relation to other people (e.g., if you find it easy to make conversation with others), some beliefs (e.g., belief in the supernatural) and perceptual experiences (e.g., in terms of your sense of smell/hearing).

Depending on your responses, you may then be invited to take part in the second stage of the study. If you agree, you will firstly be asked to attend the lab for a short virtual reality task, as well some questionnaires relating to your personality traits and your thoughts and feelings, with particular emphasis on social situations.

You will also be asked to take part in a semi-structured interview, in which the researcher will ask you about your experience of the virtual environment. With your consent, some of your responses will be audio-recorded. These recordings will be destroyed at the end of the study.

- Short Virtual Reality (VR) task: you will wear a VR headset and be immersed in an everyday environment (a pub) for 5 minutes and you will be asked to rate your experience afterwards.

After 40 days you will be asked to come to the lab to repeat the virtual reality task, as well as some questionnaires.

Do I have to take part?

Participation is completely voluntary. You should only take part if you want to and choosing not to take part will not disadvantage you in anyway. Once you have read the information sheet, please contact us if you have any questions that will help you make a decision about taking part. If you decide to take part, we will ask you to sign a consent form and you will be given a copy of this consent form to keep.

Incentives

You will enter into a draw of four **Amazon vouchers worth £25** for completing the online survey. You will receive a further **£10 (cash)** for each attended appointment (max 2 appointments = total £20) as a remuneration for your participation upon completing the lab-based assessments.

What are the possible risks of taking part?

When people use virtual reality systems, some people sometimes experience a degree of nausea. If at any time you wish to stop taking part in the study due to this or any other reason, please just say so and we will stop immediately. There has been some research that suggests that people using head-mounted displays might experience some disturbances in vision afterwards. No long-term studies are known to us, but the studies which have been carried out do testing after about 30 minutes, and find the effect is till sometimes there. It is advised that participants do not drive a car, motorcycle, or use any piece of complicated machinery in the four hours immediately following being in virtual reality. There have been various reported side effects of using virtual reality equipment, such as “flashbacks”. There is a possibility that an epileptic episode may be generated by the virtual reality equipment. This, for example, has been reported for computer video games. If you have a history of epilepsy, we would not want you to take part in the study.

What are the possible benefits of taking part?

As well as being compensated for you time, you will have the opportunity to contribute to this research and play a key role in the future development of a novel and effective assessment and treatment approach to help people with serious mental health problems facing difficulties with social situations.

Data handling and confidentiality

Your data will be processed in accordance with the General Data Protection Regulation 2016 (GDPR). Your responses will be confidential. In Stage 1, we will ask for a contact email address in case we need to contact you for the virtual reality study or the Amazon vouchers. We will also ask for your name and a phone number but providing this information is optional. We do not collect any other identifying information such as your IP address or your home address. All research data stored electronically will be encrypted. When data is downloaded to a secure file, your contact detail(s) will be kept separate from your survey data and you will be identified by a participant number.

Data Protection Statement

The data controller for this project will be King's College London (KCL). The University will process your personal data for the purpose of the research outlined above. The legal basis for processing your personal data for research purposes under GDPR is a 'task in the public interest'. You can provide your consent for the use of your personal data in this study by completing the consent form that has been provided to you.

You have the right to access information held about you. Your right of access can be exercised in accordance with the General Data Protection Regulation. You also have other rights including rights of correction, erasure, objection, and data portability. Questions, comments and requests about your personal data can also be sent to the King's College London Data Protection Officer Mr Albert Chan info-compliance@kcl.ac.uk. If you wish to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk.

What if I change my mind about taking part?

You are free withdraw at any point of the study, without having to give a reason. Withdrawing from the study will not affect you in any way. In Stage 1, before you begin the survey, we will ask you to complete a brief consent form to ensure that you are eligible and understand what is involved in the study. However, there will be no consequences if you choose to withdraw from the study at any time. You will just need to contact the research team to let us know if you do not want your data to be used. Partially completed questionnaires will not be used. If you are invited for the virtual reality study, you are free to decline this invitation.

If after taking part in Stage 2 you decide that you would no longer want your data to be used, you are entitled to ask for your data to be removed from the project, up until the time the results of the study are written up for publication (31st March 2020).

What will happen to the results of the study?

The results of this study will be used for academic publications and presentations, but all data will be anonymised.

Who should I contact for further information?

If you have any questions or require more information about this study, please contact:

Mr Fabio Massaro

King's College London

PO78, Institute of Psychiatry, Psychology & Neuroscience

De Crespigny Park, Denmark Hill

London, SE5 8AF

fabio.massaro@kcl.ac.uk

What if I have further questions, or if something goes wrong?

If this study has harmed you in any way or if you wish to make a complaint about the conduct of the study you can contact King's College London using the details below for further advice and information:

Dr Lucia Valmaggia

Head of Virtual Reality Lab

King's College London

Institute of Psychiatry, Psychology and Neuroscience

Department of Psychology (PO77)

De Crespigny Park, Denmark Hill,

London, SE5 8AF

Lucia.valmaggia@kcl.ac.uk

The Chair, Psychiatry, Nursing and Midwifery Research Ethics Subcommittee.

rec@kcl.ac.uk

Thank you for reading this information sheet and for considering taking part in this research.

Page 2: CONSENT FORM

1. Please confirm that you have read the Information Sheet about the study (on the previous page). ✱ *Required*

- ○ I have read the Information Sheet

2. Please confirm that you are a working age adult, i.e. your age is between 18 and 65 ✱ *Required*

- ○ I am a working age adult (aged 18-65)

3. Please confirm that you are a fluent speaker of English ✱ *Required*

- ○ I am a fluent speaker of English

4. Please confirm that you are willing to be invited to take part in the virtual reality study at the Institute of Psychiatry, Psychology and Neuroscience (for an appointment that is convenient for you between July 2019 and March 2020). ✱ *Required*

- ○ I am willing to be invited to the Institute of Psychiatry, Psychology and Neuroscience for the virtual reality study

5. Please confirm that you have not been diagnosed with a serious mental health problem (e.g. psychosis or bipolar disorder), a neurological disorder, a learning disability, or epilepsy. ✱ *Required*

- [ ] I have not been diagnosed with a serious mental health problem, a neurological disorder, a learning disability, or epilepsy

6. Please type the word 'I consent' in the box below to confirm that you consent to taking part in this survey. ✱ *Required*

Page 3: GENERAL INFORMATION

7. We would be very grateful to find out some general information about you. What is your age? ✱ *Required*

○ 18	○ 19	○ 20
○ 21	○ 22	○ 23
○ 24	○ 25	○ 26
○ 27	○ 28	○ 29
○ 30	○ 31	○ 32
○ 33	○ 34	○ 35
○ 36	○ 37	○ 38
○ 39	○ 40	○ 41
○ 42	○ 43	○ 44
○ 45	○ 46	○ 47
○ 48	○ 49	○ 50
○ 51	○ 52	○ 53
○ 54	○ 55	○ 56
○ 57	○ 58	○ 59
○ 60	○ 61	○ 62
○ 63	○ 64	○ 65

8. How would you describe your gender? ✱ *Required*

○ Male	○ Female	○ Other

9. Which of the following best describes your employment status? ✱ *Required*

○ Student	○ Part-time PAID employment	○ Full-time PAID employment

- Part-time UNPAID employment
- Full-time UNPAID employment
- Unemployed
- Other

10. Which of the following best decribes your marital/relationship status? ✱ *Required*

- Single
- In a relationship but not cohabiting
- Cohabiting
- Married
- Separated
- Divorced
- Widowed
- Other

11. Which of the following best describes your current living arrangements? ✱ *Required*

- I live with my parents
- I own the house/flat where I am living
- I am renting a house/flat
- I am renting a bed-sit
- I am renting a room in house share
- I am staying in a hostel
- I am homeless
- Other

12. Which of the following best describes your highest academic achievement?

- No formal qualifications
- O-Levels, GCSEs, GCEs
- AS, A-levels, (G)NVQ
- Undergraduate degree
- Masters degree
- Doctorate, PhD

13. Which of the following best describes your ethnicity? ✱ *Required*

- ○ Asian/ Asian British
- ○ Black/ African/ Caribbean/ Black British
- ○ Mixed/Multiple ethnic groups
- ○ Other ethnic group
- ○ White

Page 4: The SPQ

14. The statements below inquire about your personal beliefs regarding a variety of situations. Consider each statement carefully. Then indicate whether the statement is true or false with regard to your typical behaviour. ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 74 answer(s).

	Yes	No
1. Do you sometimes feel that things you see on TV or read in the newspaper have a special meaning for you?	☐	☐
2. I sometimes avoid going to places where there will be many people because I will get anxious	☐	☐
3. Have you had experiences with the supernatural?	☐	☐
4. Have you often mistaken objects or shadows for people, or noises for voices?	☐	☐
5. Other people see me as slightly eccentric (odd).	☐	☐
6. I have little interest in getting to know other people.	☐	☐
7. People sometimes find it hard to understand what I am saying.	☐	☐
8. People sometimes find me aloof and distant.	☐	☐
9. I am sure I am being talked about behind my back.	☐	☐
10. I am aware that people notice me when I go out for a meal or to see a film.	☐	☐
11. I get very nervous when I have to make polite conversation.	☐	☐
12. Do you believe in telepathy (mind-reading)?	☐	☐
13. Have you ever had the sense that some person or force is around you, even though you cannot see anyone?	☐	☐
14. People sometimes comment on my unusual mannerisms and habits.	☐	☐
15. I prefer to keep myself to myself.	☐	☐

16. I sometimes jump quickly from one topic to another when speaking.	☐	☐
17. I am not good at expressing my true feelings by the way I talk and look.	☐	☐
18. Do you often feel that other people have it in for you?	☐	☐
19. Do some people drop hints about you or say things with a double meaning?	☐	☐
20. Do you ever get nervous when someone is walking behind you?	☐	☐
21. Are you sometimes sure that other people can tell what you are thinking?	☐	☐
22. When you look at a person, or yourself in a mirror, have you ever seen the face change right before your eyes?	☐	☐
23. Sometimes other people think that I am a little strange.	☐	☐
24. I am mostly quiet when with other people.	☐	☐
25. I sometimes forget what I am trying to say.	☐	☐
26. I rarely laugh and smile.	☐	☐
27. Do you sometimes get concerned that friends or co-workers are not really loyal or trustworthy?	☐	☐
28. Have you ever noticed a common event or object that seemed to be a special sign for you?	☐	☐
29. I get anxious when meeting people for the first time.	☐	☐
30. Do you believe in clairvoyance (psychic forces, fortune telling)?	☐	☐
31. I often hear a voice speaking my thoughts aloud.	☐	☐
32. Some people think that I am a very bizarre person.	☐	☐
33. I find it hard to be emotionally close to other people.	☐	☐
34. I often ramble on too much when speaking.	☐	☐
35. My "nonverbal" communication (smiling and nodding during a conversation) is not very good.	☐	☐
36. I feel I have to be on my guard even with friends.	☐	☐

37. Do you sometimes see special meanings in advertisements, shop windows, or in the way things are arranged around you?	☐	☐
38. Do you often feel nervous when you are in a group of unfamiliar people?	☐	☐
39. Can other people feel your feelings when they are not there?	☐	☐
40. Have you ever seen things invisible to other people?	☐	☐
41. Do you feel that there is no one you are really close to outside of your immediate family, or people you can confide in or talk to about personal problems?	☐	☐
42. Some people find me a bit vague and elusive during a conversation.	☐	☐
43. I am poor at returning social courtesies and gestures.	☐	☐
44. Do you often pick up hidden threats or put-downs from what people say or do?	☐	☐
45. When shopping do you get the feeling that other people are taking notice of you?	☐	☐
46. I feel very uncomfortable in social situations involving unfamiliar people.	☐	☐
47. Have you had experiences with astrology, seeing the future, UFOs, ESP, or a sixth sense?	☐	☐
48. Do everyday things seem unusually large or small?	☐	☐
49. Writing letters to friends is more trouble than it is worth.	☐	☐
50. I sometimes use words in unusual ways.	☐	☐
51. I tend to avoid eye contact when conversing with others.	☐	☐
52. Have you found that it is best not to let other people know too much about you?	☐	☐
53. When you see people talking to each other, do you often wonder if they are talking about you?	☐	☐
54. I would feel very anxious if I had to give a speech in front of a large group of people.	☐	☐

55. Have you ever felt that you are communicating with another person telepathically (by mind-reading)?	☐	☐
56. Does your sense of smell sometimes become unusually strong?	☐	☐
57. I tend to keep in the back ground on social occasions.	☐	☐
58. Do you tend to wander off the topic when having a conversation?	☐	☐
59. I often feel that others have it in for me.	☐	☐
60. Do you sometimes feel that other people are watching you?	☐	☐
61. Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?	☐	☐
62. I attach little importance to having close friends.	☐	☐
63. Do you sometimes feel that people are talking about you?	☐	☐
64. Are your thoughts sometimes so strong that you can almost hear them?	☐	☐
65. Do you often have to keep an eye out to stop people from taking advantage of you?	☐	☐
66. Do you feel that you cannot get "close" to people?	☐	☐
67. I am an odd, unusual person.	☐	☐
68. I do not have an expressive and lively way of speaking.	☐	☐
69. I find it hard to communicate clearly what I want to say to people.	☐	☐
70. I have some eccentric (odd) habits.	☐	☐
71. I feel very uneasy talking to people I do not know well.	☐	☐
72. People occasionally comment that my conversation is confusing.	☐	☐
73. I tend to keep my feelings to myself.	☐	☐
74. People sometimes stare at me because of my odd appearance.	☐	☐

Page 5: CONTACT DETAILS

If you are selected for the virtual reality study or if you are the winner or one of four £25 Amanzon vouchers, we will contact you by email. If you are willing to provide your telephone number, we may also contact you by telephone.

15. What is your email address?

16. What is your name?

17. What is your telephone number?

18. How did you find out about this study?

- Twitter
- Facebook
- Other online social network (not Twitter/Facebook)
- Messaging/chat service (e.g. SMS, WhatsApp)
- Website
- Email

- Online advert
- Online forum
- Poster/Flyer
- Verbally informed
- Other
- Prefer not to say

Page 6: END OF SURVEY

Thank you very much for completing this survey

You will now be entered into a prize draw to win one of four £25 Amazon vouchers, and for the chance to come to the Institute of Psychiatry, Psychology & Neuroscience (Denmark Hill, South East London) to take part in a virtual reality study.

We will get in touch if you are one of the successful winners of the Amazon vouchers or if we would like to invite you to take part in the virtual reality study. If you are invited for the virtual reality, you will be sent another information sheet in electronic format and a consent form. At this point you can decide if you wish to take part in the virtual reality study.

If this survery has raised any difficult thoughts or feelings for you and you wish to discuss them further, we would advise that you contact your GP or your local NHS IAPT (Improving Access to Psychological Therapies) service. If you wish to speak to someone immediately about these thoughts or feelings, you can contact the Samaritans on 116 123.

Save or print this page if you wish to keep a copy for your records.

If you have any questions, please contact Mr Fabio Massaro or Dr Lucia Valmaggia

Mr Fabio Massaro

King's College London

PO78, Institute of Psychiatry, Psychology and Neuroscience

De Crespigny Park, Denmark Hill

London, SE5 8AF

fabio.massaro@kcl.ac.uk

Dr Lucia Valmaggia

Head of Virtual Reality Lab

King’s College London

Institute of Psychiatry, Psychology and Neuroscience

Department of Psychology (PO77)

De Crespigny Park, Denmark Hill,

London, SE5 8AF

lucia.valmaggia@kcl.ac.uk

28. Appendix IV Study 1 invitation email

Subject: Virtual Reality study: Invitation to IoPPN [Participant number: *]**

Dear [Name/email],

Thank you for completing the online survey as part of the "Virtual Reality and Social Situations" study (as per participant information sheet attached).

We would like to invite you to the Institute of Psychiatry, Psychology & Neuroscience (IoPPN), King's College London, De Crespigny Park, Denmark Hill, London SE5 8AF.

This part of the study will involve piloting a new Virtual Reality (VR) platform and aims to understand how people respond when entering a social environment in virtual reality. If you choose to accept this invitation, **you will be paid £10 for approximately 1 hour of your time**. I have attached the Consent Form, which you will need to read and sign if you decide to take part in the VR study.

Booking your VR Appointment

We use the Internet calendar tool Doodle to schedule appointments. This means that you can book yourself in for an appointment that is most convenient to you. In order to book your appointment, you will need your unique, 4 digit participant number that has been assigned to you.

Your participant number is: [Insert number]

Click the link below to book your appointment. Simply enter your unique 4-digit participant number in your chosen timeslot (where it says 'your name'). You do not need to enter any other information. We currently have appointment times on the following dates:

Expand the poll if needed to see all appointment times. Please reserve just one appointment. If you book, change or cancel an appointment less than 24 hours before the appointment is due to take place, I would be very grateful if you could email me in addition to amending the Doodle.

If you are unable to attend any of the available appointments, please contact me with your availability.

On your VR Appointment Day

For appointments at 5 pm or later Mon-Fri or anytime on Sat/ Sun: please come to reception of the Institute of Psychiatry, Psychology and Neuroscience: Main Building, 16 De Crespigny Park, London, SE5 8AF (reception phone no: 020 7848 0002).

For appointments between 9 am and 4.45 pm Mon-Fr: please come to reception of the Henry Wellcome Building (reception phone no: 020 7848 0033).

Please note: these buildings are next to each other.

Upon arrival, please report to reception and you will then be met by a member of the research team.

Please find a map of the IoPPN Denmark Hill Campus here:

https://www.kcl.ac.uk/core-assets/maps/detail/ioppn.pdf

Travel advice for getting to IoPPN Denmark Hill Campus can be found here:

https://www.kcl.ac.uk/ioppn/contact/findus/index

Please bring a signed copy of the attached consent form with you on the day. If this is not possible, blank copies will be available at your appointment.

Please do not consume any alcohol or drugs for at least 8 hours before your appointment.

If you no longer wish to participate in this study or are unable to attend, I would be very grateful if you would let me know as soon as possible. If I do not hear from you within 2 weeks, I will assume that you do not wish to participate.

Many thanks. We look forward to seeing you at the IoPPN.

Kind regards,

Fabio

Mr Fabio Massaro
Trainee Clinical Psychologist
King's College London
PO78, Institute of Psychiatry, Psychology & Neuroscience
De Crespigny Park, Denmark Hill
London, SE5 8AF.
fabio.massaro@kcl.ac.uk

29. Appendix V Participant information sheet, consent form and participation sheets

INFORMATION SHEET FOR PARTICIPANTS

REC Reference Number: HR-18/19-11624

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

Study title: "Virtual Reality and social situations"

Thank you for completing the online survey on your response to social situations. We would now like to invite you to take part in a virtual reality study being conducted for a doctoral degree at the Institute of Psychiatry, Psychology and Neuroscience, King's College London. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide if you are willing to participate, you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

Why are we doing this research?
Using virtual reality, we are looking to improve our understanding of how people think and feel in social situations. We are also exploring whether undertaking the same virtual reality task twice (at two different times) will influence people's thoughts and feelings. The results of the study will inform the future development of a novel and effective assessment and treatment approach to help individuals with serious mental health problems facing difficulties with social situations.

Who is eligible to participate?
We are looking for participants aged between 18 and 65 years who have no history or current diagnosis of a serious mental health illness or substance abuse. You can participate if you are fluent in English, have normal hearing and do not suffer from photosensitive epilepsy.

When and where will the study take place?
If you decide to take part in the virtual reality study, you will be invited to the Institute of Psychiatry, Psychology & Neuroscience, King's College London (near Denmark Hill station), for an appointment. This appointment will take one hour. With your consent, after 40 days you will be re-invited to take part in the exact same study, held at the same location for the same duration.

What will you be asked to do?
The appointment will consist of three separate parts.

Part 1: You will be interviewed by a researcher and asked to fill out some online questionnaires for approximately 20 minutes. These questions will ask you about your personality traits and your thoughts and feelings, with particular emphasis on social situations.

Part 2: You will be given a virtual reality headset and joystick to enter a virtual social situation for approximately 5 minutes, where computer-controlled avatars will be present. You will be asked to carry out some brief tasks whilst in the virtual reality. *Instructions on how to use the virtual reality equipment will be given to ensure you feel comfortable with the equipment and a researcher will be present at all times.*

Part 3: You will be asked by a researcher about your experience of the virtual environment and will be given some questionnaires to complete. With your consent, some of your responses will be audio-recorded. *These recordings will be destroyed at the end of the study.*

Study Outcomes
The results of the study are unlikely to be published before 2020. Copies of the published results will be available to you on request.

How will we maintain your privacy and confidentiality?

All of your personal data will be anonymised by replacing it with a numerical identification number. Any data we receive from you will be stored in a password protected electronic format. The anonymised results of this study will be used for academic publications and presentations. Your responses to our questions will remain completely confidential within the limits of the law. Confidentiality will need to be broken in the event that you disclose information that suggests your own health and safety or that of someone else is currently in danger.

Participation and withdrawal
It is up to you to decide whether or not to take part in this study. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form at each stage of the study. You will be free to withdraw from the study at any time, without needing to provide a reason. For those participants who have either withdrawn or were excluded, all data will be removed from the study immediately. If after your participation, you no longer wish for your data to be included in the publication of this study, you are free to withdraw your data, up until the time the results of the study are written up for publication (31st March 2020).

Will you be compensated for your time?
You will be given **£10 cash** for each attended appointment (maximum of 2 appointments = £20) at the end of each appointment.

Are there any risks involved in participating?
When people use virtual reality systems, some people sometimes experience some degree of nausea. If at any time you wish to stop taking part in the study due to this or any other reason, please just say so and we will stop immediately. There has been some research that suggests that people using head-mounted displays might experience some disturbances in vision afterwards. No long-term studies are known to us, but the studies which have been carried out do testing after about 30 minutes, and find the effect is till sometimes there. It is advised that participants do not drive a car, motorcycle, or use any piece of complicated machinery in the four hours immediately following being in virtual reality. There have been various reported side effects of using virtual reality equipment, such as "flashbacks". There is a possibility that an epileptic episode may be generated by the virtual reality equipment. This, for example, has been reported for computer video games. If you have a history of epilepsy, we would not want you to take part in the study.

Participation in future studies
If you agree to take part you will be asked whether you are happy to be contacted about participation in future studies. Your participation in this study will not be affected should you choose not to be re-contacted.

Who has reviewed the study?
This study is being supervised by Dr Lucia Valmaggia and Dr Elena Antonova. All research at King's College London is also reviewed by a Research Ethics Subcommittee, to protect your safety, rights, wellbeing and dignity. This study was reviewed by the Psychiatry, Nursing & Midwifery Subcommittee (REF: HR-18/19-11624).

Contact details
If you have any questions relating to this research, or concerns about participation, please contact:

Mr Fabio Massaro
King's College London
PO78, Institute of Psychiatry, Psychology & Neuroscience
De Crespigny Park, Denmark Hill
London, SE5 8AF.
fabio.massaro@kcl.ac.uk

Dr Lucia Valmaggia
Head of Virtual Reality Lab
King's College London
Institute of Psychiatry, Psychology and Neuroscience
Department of Psychology (PO77)
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Lucia.valmaggia@kcl.ac.uk

We wish to thank you for taking the time to read this sheet and considering taking part in the research study.

IF YOU HAVE ANY QUESTIONS AT ALL, PLEASE ASK THEM NOW.

CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: "Virtual Reality and social situations"

King's College Research Ethics Committee Ref: HR-18/19-11624

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Please tick or initial

- **I agree to take part in the above research. I have read the Participant information sheet. I understand what my role will be in this research. All my questions have been answered with satisfaction.** ☐
- **I understand that if I decide at any time during the research that I no longer wish to participate in this project, I can notify the researchers involved and withdraw from it immediately without giving any reason. Furthermore, I understand that I will be able to withdraw my data up until 31st March 2020.** ☐
- **I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the GDPR and Data Protection Act 2018.** ☐
- **I consent to my anonymous data being shared with researchers outside of the research team.** ☐
- **I agree to being re-contacted about future studies.** ☐
- **I understand that everything I disclose during the study will remain completely confidential within the limits of the law. I understand that confidentiality will need to be broken in the event that I disclose information that suggests my own health and safety or that of someone else is currently in danger.** ☐
- **I consent to my interview being audio-recorded.** ☐
- **I consent to my audio recording being shared with an external transcription service.** ☐

Participant's Statement:

I, _____

agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet about the project, and understand what the research study involves.

Signed **Date**

Investigator's Statement:

I, _____

Confirm that I have carefully explained the nature and demands of the proposed research to the participant.

Signed **Date**

VIRTUAL REALITY AND SOCIAL SITUATIONS STUDY

Confirmation of Participation

PARTICIPANT NUMBER: ☐

I confirm that I have participated in first part of the Virtual Reality & Social Situations study at the Institute of Psychiatry, Psychology & Neuroscience, King's College London.

NAME of participant……

SIGNATURE of participant……

DATE……

I confirm that the person named above has participated in the first part of the Virtual Reality & Social Situations study at the Institute of Psychiatry, Psychology & Neuroscience, King's College London.

NAME of researcher……

SIGNATURE of researcher……

DATE……

VIRTUAL REALITY AND SOCIAL SITUATIONS STUDY

Confirmation of Participation

PARTICIPANT NUMBER: ☐

I confirm that I have participated in the second and final part of the Virtual Reality & Social Situations study at the Institute of Psychiatry, Psychology & Neuroscience, King's College London.

NAME of participant……

SIGNATURE of participant……

DATE……

I confirm that the person named above has participated in the second and final part of the Virtual Reality & Social Situations study at the Institute of Psychiatry, Psychology & Neuroscience, King's College London.

NAME of researcher……

SIGNATURE of researcher……

DATE……

30. Appendix VI Instruction manual for VR data collection

VR DATA COLLECTION INSTRUCTIONS FOR ONE PARTICIPANT

PART 1

R1. Meet participant in reception of HWB or main building. Bring them up to Interview room.

R1. ***Interview room***

- **Briefing:** *Sample script: "Thank you for coming to do the virtual reality study today. You were sent an Information Sheet. Did you read the Information Sheet?* [If yes:] *Did you have any questions?* [Use information sheet as prompt and answer questions.] [If no:] *Would you like to have a quick read of it now? Take your time ... Did you have any questions?* [If participant would like a summary, key points in brief are:] *"The purpose of today is to do a virtual reality task and ask you a few questions before and after about how you found the experience. The virtual reality scenario is a social situation. All of the information that we collect today is completely confidential. You are free to stop the study or take a break at any time."* [If the participant asks any questions about the design of the study or how they were selected:] *"I'm afraid I can't answer that question before you do the virtual reality task but there will be a debriefing afterwards where I will be able to answer any questions."*
- **Consent form:** Sign or collect signed copy. Researcher to sign and retain 1 copy. Make sure participant has completed all sections correctly before you sign. Ask participant if they would also like a copy for their records and, if so, complete a second consent form.
- **Questions on tablet:** *Sample script: "We would just like to ask you a few questions before you do the virtual reality task. We have the questions on this tablet. Let me know if you have any questions ...*" [If participant finds question formatting on tablet difficult:] *"You may find it easier to switch to 'tableless mode'."*
- **End:** *Sample script: "It is now time to do the virtual reality task with my colleague. I will take you through to them"*

  R1 to stay with participant in holding area until R2 is ready to collect them

PART 2

On screen: VR PUB > double click> RUN (Loading). VR headset must be facing the screen while scenario is loading.

R2. ***VR lab***

- **Introduction:** *Sample script: "This is the part of the study where we will do the virtual reality task"*
- **Explain VR equipment**: Before putting on the headset, show the participant the Oculus headset and the joypad. Show them which button on the joypad they will be able to use. Tell the participant: *"You will be able to move around with a combination of turning with your body and by using the joypad. Move around slowly at first as you get used to the virtual environment; otherwise you might feel dizzy. If you've used a joypad before, it might be a bit different to what you are used to as you will be partially guided in your movement and cannot move completely freely".* Demonstrate this to participant while holding the joypad.
- **Start VR:** Get participant into position, holding joypad and wearing VR headset. Make sure headset cable is not tangled. Sample script: *"Don't worry about the cable. I will make sure you do not get tangled."* Blue light on headset must be on. Once the participant is comfortable and ready, press PLAY.
- **Demo VR exercise:** [Now read the following:] "*You will first be in a street. Have a look around the street slowly ... When you are ready, use the joypad to move yourself to the green circle on the ground ... You will get to a pub. Turn your body to the right to face the pub ... In the pub look for more green circles on the ground. You will need to go from one green circle to another. If you cannot find a green circle, have a look around for it. When you get to a green circle, you will need to stop for a little while. While you are in the pub please try get an impression of what the people in the pub thinks about you and what you think about them. If someone asks you a question, try to reply to them"* [Everyone MUST get this instruction.] *"Do you have any questions?"*
- **Main VR task:** Once the VR programme has uploaded press PLAY. The participants will then have a chance to move around and to rate their experience of the VR environment by using the right bumper.

  They will then move to the entrance of the pub. Press PLAY at pub doorway
  AFTER PATRICK > CONTINUE
  2ND INTERACTION (JOHN) > CONTINUE
  AFTER question about FAVOURITE TV PROGRAMME > CONTINUE
  AFTER question TELL ME MORE ABOUT IT> CONTINUE
  AFTER participants finish to talk>CLOSING INSTRUCTION > CONTINUE
  LEAVE THE PUB
- **FIDELITY:** Record on tablet. DO NOT SPEAK TO PARTICIPANT WHILE IN THE PUB UNLESS NECESSARY.
- **Remove VR equipment**
- **Questions on tablet:** *"Now that you've done the virtual reality task, we would just like to ask you a few more questions on this tablet. ...* [If participant finds question formatting on tablet difficult:] *You may find it easier to switch to 'tableless mode'.*

- **End:** *Sample script: "Thank you for doing the virtual reality task. I am just going to take you back to my colleague who has a few more questions for you and can answer any questions you might have"*

  R2 to stay with participant in holding area until R1 is ready to collect them

PART 3

R1. ***Interview room***

- **Post-VR semi-structured interview:** See form for script.
- **General debrief:** *Sample script: "Now that you've completed the main parts of the study, I wanted to give you a little more information about the research. It's also an opportunity for you to ask any further questions. This study is composed of 2 sub-studies. The first sub-study, which you completed today, looks at the various emotional responses that people have in a virtual reality social situation. In particular, we are looking at how the virtual reality scenario of a social situation affects peoples with different personality. For this reason, we have selected a variety of participants with different personality to come and do the virtual reality task* [Pause for any questions]. *Given that all participant data are anonymised, we do not know which personality participants that do the virtual reality have. Do you have a*ny *questions about study?*
- **Second part of the study –** *The second sub-study looks at whether the repeated exposure to VR leads to habituation or sensitisation effects. In order to do this, we will invite you to re-take this study after 40 days from today. You will be reimbursed an additional £10 if you attend the second appointment.*
- **[Optional] Normalise paranoia and:**
    - [If participant feels paranoid and has any concerns about their paranoia, normalise paranoia in the general population:] *"Paranoia is very common. Everyone experiences some degree of paranoia."*
- **[Optional] Paranoia leaflet/signpost to GP:** [If participant has further concerns about their paranoia, give them the paranoia leaflet. If participant has still further concerns and feels they need to discuss this with someone, signpost them to contacting their GP:] *Sample script: "If you feel that this has raised any difficult thoughts or feelings for you and that you would like to discuss them further with someone, we would suggest that you discuss this with your GP."*
- **[Optional] Results of study:** [If participants would like to know about the results of the study:] *Sample script: "We will be happy to send you the final report when it is completed; however it is important for you to attend the second appointment in 40 days so that the study has completed and reliable data. We can have the results emailed to you"* [Record at the bottom of the Post-VR semi-structured interview sheet if participant would like published report/paper emailed to them].
- **Book 2nd appointment (after 40 days):** [Ask participant to book the 2nd appointment (after 40 days from today):] *Sample script: "Would be ok if we book now your second appointment? As previously mentioned, this will be in 40 days' time from today and you will be reimbursed an additional £10 if you attend it.* [Record on the A4 diary the provisional date for 2nd appointment].
- **Keeping debrief confidential:** *Sample script: "If you happen to know other participants in the virtual reality study, we would be very grateful if you do not share this explanation with them until the virtual reality data collection is completed."*
- **Payment:** Ask participant to sign the Research Participant Expense Receipt and give £10 cash.
- **Participation confirmation:** Complete Confirmation of participation form (for either t1 or t2)
- **End:** *Sample script: "Thank you very much for coming today [and I will I see you in 40 days]. I will show you out"*

See participant out of building

31. Appendix VII Study 1 pre-VR online surveys output

PRE-VR QUESTIONS (t1)

Page 1: WELCOME

1. Participant number: ✱ *Required*

2. Researcher initials: ✱ *Required*

VIRTUAL REALITY AND SOCIAL SITUATIONS STUDY

Pre-VR Questions

You have been invited to experience a brief social situation in virtual reality. Before we ask you to enter the virtual reality, we would like to ask you a few questions about your thoughts and feelings. If you have any questions the researcher will be available to assist throughout the process.

Page 2: IPSM

3. A number of statements are listed below which relate to how you might feel about yourself and other people in your life. Please indicate with a tick in the appropriate place how each one applies to you - i.e. whether it is "very like you", "moderately like you", "moderately unlike you" or "very unlike you". Respond to each statement in terms of how you are GENERALLY and not necessarily just at present. There are no right or wrong answers. ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 36 answer(s).

	Very likely	Mod. likely	Mod. unlikely	Very unlikely
1. I feel insecure when I say goodbye to people	☐	☐	☐	☐
2. I worry about the effect I have on other people	☐	☐	☐	☐
3. I avoid saying what I think for fear of being rejected	☐	☐	☐	☐
4. I feel uneasy meeting new people	☐	☐	☐	☐
5. If others knew the real me, they would not like me	☐	☐	☐	☐
6. I feel secure when I'm in a close relationship	☐	☐	☐	☐
7. I don't get angry with people for fear that I may hurt them	☐	☐	☐	☐
8. After a fight with a friend, I feel uncomfortable until I have made peace	☐	☐	☐	☐
9. I am always aware of how other people feel	☐	☐	☐	☐
10. I worry about being criticised for things I have said or done	☐	☐	☐	☐
11. I always notice if someone doesn't respond to me	☐	☐	☐	☐
12. I worry about losing someone close to me	☐	☐	☐	☐
13. I feel that people generally like me	☐	☐	☐	☐
14. I will do something I don't want to do rather than offend or upset someone	☐	☐	☐	☐
15. I can only believe that something I have done is good when someone tells me it is	☐	☐	☐	☐
16. I will go out of my way to please someone I am close to	☐	☐	☐	☐
17. I feel anxious when I say goodbye to people	☐	☐	☐	☐
18. I feel happy when someone compliments me	☐	☐	☐	☐
19. I fear that my feelings will overwhelm people	☐	☐	☐	☐
20. I can make other people feel happy	☐	☐	☐	☐

21. I find it hard to get angry with people	☐	☐	☐	☐
22. I worry about criticising other people	☐	☐	☐	☐
23. If someone is critical of something I do, I feel bad	☐	☐	☐	☐
24. If other people knew what I am really like, they would think less of me	☐	☐	☐	☐
25. I always expect criticism	☐	☐	☐	☐
26. I can never be really sure if someone is pleased with me	☐	☐	☐	☐
27. I don't like people to really know me	☐	☐	☐	☐
28. If someone upsets me, I am not able to put it easily out of my mind	☐	☐	☐	☐
29. I feel others do not understand me	☐	☐	☐	☐
30. I worry about what others think of me	☐	☐	☐	☐
31. I don't feel happy unless people I know admire me	☐	☐	☐	☐
32. I am never rude to anyone	☐	☐	☐	☐
33. I worry about hurting the feelings of other people	☐	☐	☐	☐
34. I feel hurt when someone is angry with me	☐	☐	☐	☐
35. My value as a person depends enormously on what others think of me	☐	☐	☐	☐
36. I care about what people feel about me	☐	☐	☐	☐

Page 3: Paranoia Scale

4. Please rate how applicable each belief is to you by selecting a number between 1 (not applicable to me) and 5 (extremely applicable to me) ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 20 answer(s).

	1 - Not at all applicable to me	2	3	4	5 - Extremely applicable to me
1. Someone has it in for me	☐	☐	☐	☐	☐
2. I sometimes feel as if I'm being followed	☐	☐	☐	☐	☐
3. I believe that I have often been punished without cause	☐	☐	☐	☐	☐
4. Some people have tried to steal my ideas and take credit for them	☐	☐	☐	☐	☐
5. My parents and family find more fault with me that they should	☐	☐	☐	☐	☐
6. No one really cares much what happens to you	☐	☐	☐	☐	☐
7. I am sure I get a raw deal from life	☐	☐	☐	☐	☐
8. Most people will use somewhat unfair means to gain profit or advantage, rather than lose it	☐	☐	☐	☐	☐
9. I often wonder what hidden reason another person may have for doing something nice for you	☐	☐	☐	☐	☐
10. It is safer to trust no one	☐	☐	☐	☐	☐
11. I have often felt that strangers were looking at me critically	☐	☐	☐	☐	☐
12. Most people make friends because friends are likely to be useful to them	☐	☐	☐	☐	☐
13. Someone has been trying to influence my mind	☐	☐	☐	☐	☐
14. I am sure I have been talked about behind my back	☐	☐	☐	☐	☐

15. Most people inwardly dislike putting themselves out to help other people	☐	☐	☐	☐	☐
16. I tend to be on my guard with people who are somewhat more friendly than expected	☐	☐	☐	☐	☐
17. People have said insulting and unkind things about me	☐	☐	☐	☐	☐
18. People often disappoint me	☐	☐	☐	☐	☐
19. I am bothered by people outside, in cars, in stores, etc., watching me	☐	☐	☐	☐	☐
20. I have often found people jealous of my good ideas just because they had not thought of them first	☐	☐	☐	☐	☐

Page 4: VAS Pre-VR

5. From the following questions, please rate how you feel "right now" from 1 ("not al all") to 10 ("extremely"). ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 4 answer(s).

	1	2	3	4	5	6	7	8	9	10
1. How stressed do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. How anxious do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. How miserable or sad do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. How happy to you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Page 5: End of survey

Thank you for answering these questions. You will now be taken to do the virtual reality task.

32. Appendix VIII Study 1 post-VR online surveys output

POST-VR QUESTIONS (t1)

Page 1: WELCOME BACK

1. Participant number: ✱ *Required*

2. Researcher initials: ✱ *Required*

VIRTUAL REALITY AND SOCIAL SITUATIONS STUDY

Post-VR Questions

Thank you for taking part in the virtual reality task. We would be very greatful if you could answer a few questions about your experience. Some of the questions will be general questions about your thoughts and feelings and others will be specific to how you felt in the virtual reality 'social situation'.

Page 2: VAS Post-VR

3. From the following questions, please rate how you feel "right now" from 1 ("not al all") to 10 ("extremely"). ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 4 answer(s).

	1	2	3	4	5	6	7	8	9	10
1. How stressed do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. How anxious do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. How miserable or sad do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. How happy to you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

4. From the following questions, please rate how you felt in the social situation from 1 ("not at all") to 10 ("extremely") ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 8 answer(s).

	1	2	3	4	5	6	7	8	9	10
5. How paranoid did you feel?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. How friendly did you find the people?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. How neutral did you find the people?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8. How hostile did you find the people?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

9. How socially anxious did you feel with the people?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10. How much did you want to avoid social interaction with others?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
11. Were you afraid that other people would not approve of you?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
12. Were you worried that you would say or do the wrong things?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5. How positively or negatively did you think the other people were thinking during the social situation? ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	6	7	8	9	10
Please rate from 1 ("very negatively") to 10 ("very positively")	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Please state which was strongest on the whole, your sense of being in the real world of the laboratory or your sense of being in the virtual social situation? ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	6	7	8	9	10

Please rate from 1 ("being in the laboratory") to 10 ("being in the virtual social situation")	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

7. How much did you enjoy the virtual reality experience? ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	6	7	8	9	10
Please rate from 1 ("did not enjoy it") to 10 ("enjoyed it very much")	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Page 3: SSPS-20

8. We are interested in your views of the other people who were in the social situation. Please tick how much you agree or disagree with the following statements based upon your thoughts when you were in the social situation. ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 20 answer(s).

	Do not agree	Agree a little	Agree moderately	Agree vey much	Totally agree
1. Someone was hostile towards me	☐	☐	☐	☐	☐
2. No-one had any particular feelings about me	☐	☐	☐	☐	☐
3. Someone had bad intentions towards me	☐	☐	☐	☐	☐
4. Someone was friendly towards me	☐	☐	☐	☐	☐
5. Someone was trying to make me distressed	☐	☐	☐	☐	☐
6. I felt very safe in their company	☐	☐	☐	☐	☐
7. Someone stared at me in order to upset me	☐	☐	☐	☐	☐
8. Everyone was trustworthy	☐	☐	☐	☐	☐
9. Someone wanted me to feel threatened	☐	☐	☐	☐	☐
10. I wasn't really noticed by anyone	☐	☐	☐	☐	☐
11. Someone had kind intentions toward me	☐	☐	☐	☐	☐
12. Someone would have harmed me in some way if they could	☐	☐	☐	☐	☐
13. Someone had it in for me	☐	☐	☐	☐	☐
14. Everyone was neutral towards me	☐	☐	☐	☐	☐
15. Someone was trying to intimidate me	☐	☐	☐	☐	☐
16. Everyone was pleasant	☐	☐	☐	☐	☐
17. Someone was trying to isolate me	☐	☐	☐	☐	☐
18. No-one had any intentions towards me	☐	☐	☐	☐	☐

19. Everyone seemed unconcerned by my presence	☐	☐	☐	☐	☐
20. Someone was trying to irritate me	☐	☐	☐	☐	☐

Page 4: General

9. Have you used virtual reality before? ✱ *Required*

- Yes
- No

10. Do you play computer games regularly? ✱ *Required*

- Yes
- No

Page 5: End of survey

Thank you for answering these questions.

33. Appendix IX Study 2 pre-VR online surveys output

PRE-VR QUESTIONS (t2)

Page 1: WELCOME

1. Participant number: ✱ *Required*

2. Researcher initials: ✱ *Required*

VIRTUAL REALITY AND SOCIAL SITUATIONS STUDY

Pre-VR Questions

You have been re-invited to experience a brief social situation in virtual reality. Before we ask you to enter the virtual reality, we would like to ask you 4 questions about how you are feeling right now. If you have any questions the researcher will be available to assist throughout the process.

Page 2: VAS Pre-VR

3. From the following questions, please rate how you feel "right now" from 1 ("not al all") to 10 ("extremely"). ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 4 answer(s).

	1	2	3	4	5	6	7	8	9	10
1. How stressed do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. How anxious do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. How miserable or sad do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. How happy do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Page 3: End of survey

Thank you for answering these questions. You will now be taken to do the virtual reality task.

---

34. Appendix X Study 2 post-VR online surveys output

POST-VR QUESTIONS (t2)

Page 1: WELCOME BACK

1. Participant number: ✱ *Required*

2. Researcher initials: ✱ *Required*

VIRTUAL REALITY AND SOCIAL SITUATIONS STUDY

Post-VR Questions

Thank you for re-taking part in the virtual reality task. We would be very greatful if you could answer a few questions about your experience. Some of the questions will be general questions about your thoughts and feelings and others will be specific to how you felt in the virtual reality 'social situation'.

Page 2: VAS Post-VR

3. From the following questions, please rate how you feel "right now" from 1 ("not al all") to 10 ("extremely"). ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 4 answer(s).

	1	2	3	4	5	6	7	8	9	10
1. How stressed do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. How anxious do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. How miserable or sad do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. How happy do you feel right now?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

4. From the following questions, please rate how you felt in the social situation from 1 ("not at all") to 10 ("extremely") ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 8 answer(s).

	1	2	3	4	5	6	7	8	9	10
5. How paranoid did you feel?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. How friendly did you find the people?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. How neutral did you find the people?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8. How hostile did you find the people?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

9. How socially anxious did you feel with the people?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10. How much did you want to avoid social interaction with others?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
11. Were you that afraid other people would not approve of you?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
12. Were you worried that you would say or do the wrong thing?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5. How positively or negatively did you think the other people were thinking during the social situation? ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	6	7	8	9	10
Please rate from 1 ("very negatively") to 10 ("very positively")	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Please state which was strongest on the whole, your sense of being in the real world of the laboratory or your sense of being in the virtual social situation? ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	6	7	8	9	10

Please rate from 1 ("being in the laboratory") to 10 ("being in the virtual social situation")	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

7. How much did you enjoy the virtual reality experience? ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	6	7	8	9	10
Please rate from 1 ("did not enjoy it") to 10 ("enjoyed it very much")	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Page 3: SSPS-20

8. We are interested in your views of the other people who were in the social situation. Please tick how much you agree or disagree with the following statements based upon your thoughts when you were in the social situation. ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 20 answer(s).

	Do not agree	Agree a little	Agree moderately	Agree vey much	Totally agree
1. Someone was hostile towards me	☐	☐	☐	☐	☐
2. No-one had any particular feelings about me	☐	☐	☐	☐	☐
3. Someone had bad intentions towards me	☐	☐	☐	☐	☐
4. Someone was friendly towards me	☐	☐	☐	☐	☐
5. Someone was trying to make me distressed	☐	☐	☐	☐	☐
6. I felt very safe in their company	☐	☐	☐	☐	☐
7. Someone stared at me in order to upset me	☐	☐	☐	☐	☐
8. Everyone was trustworthy	☐	☐	☐	☐	☐
9. Someone wanted me to feel threatened	☐	☐	☐	☐	☐
10. I wasn't really noticed by anyone	☐	☐	☐	☐	☐
11. Someone had kind intentions towards me	☐	☐	☐	☐	☐
12. Someone would have harmed me in some way if they could	☐	☐	☐	☐	☐
13. Someone had it in for me	☐	☐	☐	☐	☐
14. Everyone was neutral towards me	☐	☐	☐	☐	☐
15. Someone was trying to intimidate me	☐	☐	☐	☐	☐
16. Everyone was pleasant	☐	☐	☐	☐	☐
17. Someone was trying to isolate me	☐	☐	☐	☐	☐
18. No-one had any intentions towards me	☐	☐	☐	☐	☐

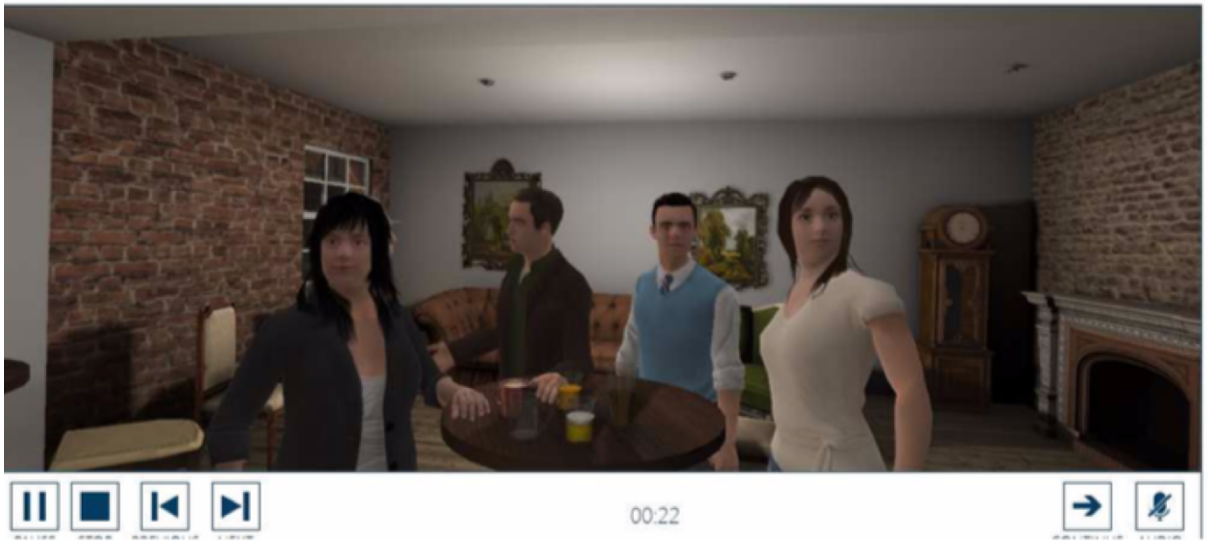
19. Everyone seemed unconcerned by my presence	☐	☐	☐	☐	☐
20. Someone was trying to irritate me	☐	☐	☐	☐	☐

Page 4: End of survey

Thank you for answering these questions.

35. Appendix XI VR scenario stills


Designed by Virtualware for King's College London


00:22

36. Appendix XII Post-VR semi-structured interview (Study 1 and Study 2)

PARTICIPANT NUMBER: [ ] **DATE:**

RESEARCHER: [ ]

Post VR Interview – Version 1, 1/6/2015

"We would now like to ask you a few questions about your experience in the VR today. These are questions we ask everyone. It will take about 5 minutes. I am going to switch on the voice recorder, OK?"

Once recording speak clearly in the microphone quoting **the person's participant number and today's date: "This is participant [PARTICIPANT NUMBER] and the date is [DATE]"**. Then probe for Information about the individual experience of the social situation by asking the following questions:

1) "What did you think about your virtual reality experience?"

2) "What thoughts ran through your mind while you were the social situation (don't worry about how trivial they seem, I am just interested in the sort of thoughts that popped into your head in the few minutes you were there). What did you think of the people in the social situation? What did you think they thought about you?"

3) "What made you think that? [i.e. on what evidence did they base their thoughts] (e.g. was it something about how you were feeling? Or was it something specific that the people did?)"

4) "Do you think the people in the social situation had any intentions towards you?"

5) "How are you feeling now? Did you feel emotional in any way while you were in the social situation?"

6) "Do you go out socially? Do you go to pubs or bars? How did you think the virtual social situation compared to your experience of being in real social situations?"

7) "Do you have any other comments?"

"Thank you. I will now turn off the voice recorder"

37. Appendix XIII Paranoia leaflet

Institute of Psychiatry

South London and Maudsley NHS Foundation Trust

wellcome trust

paranoid thoughts

Information about paranoid thoughts and paranoia

It sometimes seems as if the one thing that unites the diverse peoples of the world is our fear of one another. Worries about other people are so common that they seem to be an essential - if unwelcome - part of what it means to be human.

The focus of this website is not on justified anxieties about others, but rather on exaggerated or unfounded fears - fears for which there is little or no convincing evidence. Exaggerated worries about others don't help us stay safe but instead can bring all manner of distress.

What is paranoia?

We could have called this section: What are fears about others? We could also have titled it: What are paranoid feelings? Or: What are persecutory beliefs? Some people use the terms delusional thoughts or, for severe instances, persecutory delusions. The feelings discussed in this website, then, go by a variety of names. Partly this is because paranoia is a term that covers a wide spectrum of experiences. What we mean is:

- The fear of something bad happening
- The idea that others may intend to cause such an event>
- The thought is exagerrated or unfounded.

These fears normally contain certain elements: a perpetrator, a type of threat, and a reason. We can suspect absolutely anyone of wanting to do us harm. Often the perpetrator is a neighbour, stranger, work colleague or family member. Occasionally it may be government organisations or spirits. Sometimes the identity of the person trying to cause the harm is unknown. The type of harm varies too. But typically the fear is of physical, psychological, social or financial harm. Why do people think others are targeting them for harm? Sometimes there's a feeling of simply being a victim, sometimes it is suspected that we're at risk because of who we are, and sometimes it because we think the threat is provoked by something we've done.

How can we tell whether our suspicious thoughts are justified?

How can we tell whether our worries are justified or not? Well, it's not always easy. If you're struggling to decide whether your suspicious thoughts are justified, ask yourself the following questions:

1. Would other people think my suspicions are realistic?
2. What would my best friend say?
3. Have I talked to others about my worries?
4. Is it possible that I have exaggerated the threat?
5. Is there any indisputable evidence for my suspicions?
6. Are my worries based on ambiguous events?
7. Are my worries based on my feelings rather than indisputable evidence?
8. Is it very likely that I would be singled out above anyone else?
9. Is there any evidence that runs contrary to my suspicions?
10. Is it possible that I'm being at all over-sensitive?
11. Do my suspicions persist despite reassurance from others that they are unfounded?

There are no hard and fast rules for deciding for certain whether a worry is realistic. But by asking yourself these questions you can determine the probability of the suspicion being justified.

The probability that your fears are unrealistic increases the more you feel that:

- No one else fully shares your suspicions
- There is no indisputable evidence to support your worries
- There is evidence against your suspicions
- It is unlikely that you would be singled out
- Your fears persist despite reassurance from others
- Your fears are based on feelings and ambiguous events

What are the causes of paranoia?

"A lot of the time I feel someone, I have no idea who, is watching me. When I'm out in public, I always get the feeling that someone is either following me or is watching me. I really don't trust anyone but myself anymore."

Read more personal accounts of paranoia

Research has identified five main factors involved in the occurrence of suspicious thoughts. All five factors are very common - all of us will have experienced at least some of them. What's important though is the way they combine. Suspicious thoughts are caused by a combination of some or all of these five factors:

- Stress and major life changes. This includes difficult relationships with others at home or at work, and becoming isolated.
- Negative emotions such as anxiety and depression. Often when we are anxious we can overestimate the chances of threat and worry too much. The way we feel has a big influence on the way we think.
- Internal unusual feelings. Stress can often cause strange feelings (eg. feeling odd, aroused, threatened), as can going without sleep. Sometimes people can feel odd because they have taken drugs such as cannabis.
- Our explanations. Paranoid thoughts are our way of trying to understand things. They are attempts to make sense of events. It's perfectly natural to try to understand the world around us - and the way we feel inside. But when we're stressed and feeling low or anxious or irritable our explanations are likely to be pretty negative. We think the worst - and often we think the worst of people around us. It can seem as if the odd or unpleasant things we've been experiencing are deliberately caused by other people.
- Reasoning (the way we think things through and come to decisions and judgements). Often suspicious thoughts can take a grip if we do not think of alternative explanations for events, and do not fully consider the evidence for and against our worries. This is sometimes called jumping to conclusions.
- So, when we are stressed and things are perhaps not going too well, we can become anxious and interpret how we feel in terms of threat from other people, without fully weighing the evidence or considering alternative explanations.

How common is paranoia?

Until very recently - the last 15 to 20 years in fact - no one suspected just how many people had paranoid thoughts. But several research projects have now lifted the lid - and the results are striking. Here are just a few statistics from some of those research projects.

- In a survey of 8580 UK adults, 21% said there'd been times over the past year when they'd felt people were against them. 9% said they'd believed that their thoughts were being controlled or interfered with by some outside force or person. 1.5% said there'd been times when they'd felt people were plotting to cause them serious harm.
- A study of 1005 adults in New York found that 10.6% believed other people were following or spying on them. 6.9% thought people were plotting against them, or trying to poison them. 4.6% believed people were either secretly testing them, or experimenting upon them.
- A French survey of 462 adults found that 25% had, at some point in their lives, felt that they were being persecuted in some way. 10.4% had sometimes believed there was a conspiracy against them.
- A study of 1202 British university students (aged 16 to 61) assessed their feelings over the previous month. 42% said that, at least once a week, they had thought that negative comments about them might be circulating. 27% had felt that people were deliberately trying to irritate them, and 19% had thought that they might be being observed or followed. 5% thought there might be a conspiracy against them.
- More than a thousand older adults (aged 55 and above) in Brooklyn, New York were assessed. 13% had, in the previous week, experienced paranoid thoughts.
- Paranoia, then, is widespread - so widespread, in fact, that around 15 to 20% of the population have frequent paranoid thoughts. Most of those people aren't much troubled by their suspicious thoughts. But a further 3 to 5 % have pretty severe paranoia. For this smaller group of people, their paranoia is often serious enough to need specialist treatment.

Overcoming paranoia

Look after yourself. We're more likely to be troubled by paranoia if we're tired or run-down or very stressed. So make sure you eat healthily, get plenty of good-quality sleep, and exercise regularly. Make time too for things you enjoy: the more positive activities you have in your life, the less scope there'll be for paranoia to take hold.

Drinking too much, and using illicit drugs, can sometimes trigger paranoid thoughts. If you think they may be a factor in your paranoia, cut back or stop completely.

Consider the pros and cons. As we've seen, underlying paranoia is a fundamental decision about whether or not to trust other people. As a device to help you explore your own approach to this issue, make a list of the pros and cons of both trusting people and mistrusting them. Have you got the balance right, do you think? Would you like to be less mistrustful? Are there experiences from your past that might be having too great an influence on how you see people now

Share your fears. We know that people who don't talk about their paranoid thoughts generally find them more upsetting. So confide in someone you trust. Getting another perspective on your worries can be really helpful.

Get to know your paranoia. Like all problems, it's much easier to cope with our paranoid thoughts if we have a clear picture of them. So for the next seven days keep a diary of your paranoid thoughts - what they are, when they occur, and what might trigger them.

You may well find that particular situations tend to spark your paranoia (perhaps being very anxious or angry or bored, for example). And that will give you the chance to think how you can prevent these situations occurring, or at least how

to deal with them better.

Incidentally, one of the great benefits of keeping a diary is that it gets your paranoid thoughts out of your head and onto paper. For many people, that can be a huge relief, and a terrific way of putting some distance between themselves and their paranoia.

Manage your worry. Worry is a very common reaction to paranoid thoughts. People fret about the harm they think other people intend towards them, and sometimes they also worry about what having these thoughts might mean (for example, that they're going mad). But the more we worry, the more anxious and fearful we become. Worry feeds on worry.

So we need to learn to manage our worry. One very useful technique is to save up all your worrying for one half-hour session every day: your worry period. And instead of worrying, try focusing your energy on solving the problem that's troubling you.

Challenge your paranoid thoughts. Choose a suspicious thought from your paranoia diary, and weigh up the evidence for and against it. Ask yourself these questions:

- Is there anything that might suggest the thought is wrong?
- What would my family or friends say if I talked to them about the thought?
- What would I say to a friend who came to me with a similar problem?
- Are there any alternative explanations for what seems to have happened?
- Are my thoughts based more on the way I feel than on solid evidence?
- Have I been jumping to conclusions?
- If I were feeling happier or less anxious or less tired, would I still see things in the same way?

Test out your thoughts. Paranoia can make people so anxious and afraid that they change their behaviour, avoiding the situations that trigger their fears. But this only reinforces their paranoia, because it robs them of the chance to discover whether or not their fears are justified.

Testing out your paranoid thoughts involves actively seeking out the situations you're afraid of. That can be pretty nerve-wracking, so you need to go carefully. Draw up a list of tasks you find difficult and start with the relatively easy ones. Once you're comfortable with those, gradually work your way up to the more difficult tasks.

Incidentally, don't put yourself in situations where you're likely to be at real risk. You may be worried about going out alone, for instance, but don't test this by going into a dangerous neighbourhood at night. Concentrate on activities that most people would find reasonable and where you think your suspicious thoughts are probably exaggerated.

Let go of your paranoid thoughts. We're bound to have suspicious thoughts from time to time. It's unrealistic to think we can put a complete stop to them, but we can improve the way we deal with these thoughts when they do occur.

The trick is not to focus on them, to develop what's known as a mindful attitude. Don't fight your thoughts and don't spend time thinking about them. Try to be detached. Watch the thought come to you, remind yourself that it doesn't matter, and let it go off into the distance. Concentrate on what you're doing, rather than what you're thinking.

People often find it helps to repeat an encouraging phrase to themselves, for example "They're only thoughts - they don't matter"; "Keep going - you're doing really well"; "These thoughts don't scare me. I can cope."

Watch Dr Daniel Freeman describe a recent research study that reveals the extent of paranoia in the general public.

This film was made by the Wellcome Trust, an independent charity supporting research into human and animal health.

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38. Appendix XIV Appointment reminder for Study 2

Dear participant,

Thank you for attending your 1st Virtual Reality appointment on [insert date]. This is a reminder of your 2nd and last VR lab-appointment scheduled for next week on **[**insert date, time and location].

I will send you a reminder nearer the time.

I look forward to seeing you next week.

Best wishes and many thanks,
Fabio

Dear participant,

I hope you are well. This is a reminder of your 2nd and last VR lab-appointment scheduled for tomorrow at [insert date, time and location]

I look forward to seeing you tomorrow.

Best wishes and many thanks,
Fabio